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CONCEPTUAL DESIGN FOR THE ARMY IN THE FIELD (CONAF) (U)

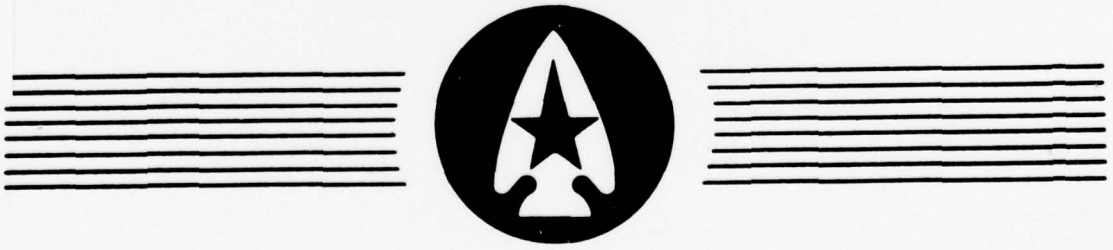
Final Report

Phase I

VOLUME II - METHODOLOGY

UNITED STATES ARMY COMBAT DEVELOPMENTS COMMAND

Concepts and Force Design Group



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FINAL STUDY

PHASE I

VOLUME II—METHODOLOGY

CONCEPTS AND FORCE DESIGN GROUP

VOLUME INDEX

NOTE: Appendix A . . . Response and Conflict Scenario for CONAF-82, in a separately bound volume, published by Headquarters, Concepts and Force Design Group, Alexandria, Virginia, February 1972.

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CHAPTER 1

OVERALL METHODOLOGY

Section I. INTRODUCTION

1. PURPOSE. This volume contains a description of the methodology developed and employed for the CONAF phase I study.

2. GENERAL. Contained herein are the various analytical procedures identified and/or developed for formulating type forces and analyzing the costs and capabilities of alternative mixes of organizations and materiel systems. They are discussed in terms of utilization, current stage of development, and recommended refinements. Also included is a brief description of the composition and responsibilities of various study advisory groups and committees established either by study directive or by the CONAF Study Advisory Group (SAG) during development of the study methodology. These groups met periodically to render key decisions or advice at critical points in the methodology.

3. SCOPE. This volume consists of three chapters. The scope of each is summarized below:

a. Chapter 1. Overall Methodology--presents the introductory information, background, and a detailed decription of the overall methodology.

b. Chapter 2. Cost and Resource Analysis Methodology--this chapter describes the methodology used; first in a cost comparison of initial and operating costs for forces and force "package" (European Based, European Reinforcing, Strategic Reserve, and Pacific); second, the annual resource requirement with appropriate schedules within annual constraints (Cost and Resource Analysis Methodology was developed by the USACDC Systems Analysis Group (SAGP)).

c. Chapter 3. Theater Force Evaluation System for CONAF--this chapter briefly describes the Theater Force Evaluation System for CONAF, its current capabilities and limitations, and programed refinements (developed by the Research and Analysis Corporation (RAC)).

Section II. OBJECTIVES AND ADVISORY GROUPS

4. METHODOLOGY OBJECTIVES:

a. To provide a set of analytical procedures for formulating type forces and analyzing the costs and capabilities of alternative mixes of organization and materiel systems.

b. To provide a methodology that is sufficiently flexible to accommodate changes as they occur, permitting timely incorporation of these changes and/or information resulting from associated studies.

c. To improve the integration of combat developments and force development efforts, thereby providing for a timely submission of information to assist the DA staff in making decisions on the future structure of the Army.

5. ADVISORY GROUPS. Several advisory groups have been established to assist in guiding the CONAF study effort and to perform key functions either in the employment or continuing refinement of the methodology. They are as follows:

a. Study Advisory Group (SAG). The SAG is the senior advisory group responsible for directing the study effort and for providing key guidance and decisions during conduct of the study. The SAG is cochaired by the Assistant Chief of Staff for Force Development (ACSFOR) and the Commanding General, Combat Developments Command (CDC). Each DA staff agency is represented, the Office of the Secretary of the Army (OSA) also is represented.

b. Working Study Advisory Group (WSAG). The WSAG is cochaired by a representative of each cochairman of the SAG and representatives from each Army staff agency. This group serves as a screening mechanism to resolve problem areas and to identify key issues that require the SAG's attention.

c. Cost Sub-Study Advisory Group. The Cost Sub-SAG was established at the direction of the SAG and is chaired by a representative of the Comptroller of the Army (COA). Membership consists of representatives from selected DA staff agencies and USACDC. The Cost Sub-SAG provides the DA direction with respect to costing methodology and costing data and recommends to the WSAG those revisions requiring the SAG's attention.

d. CONAF Evaluation Assistance Group (CEAG). The CEAG is chaired by the USACDC Scientific Advisor and consists of senior scientific advisors from the OSA, the DA staff, and selected USACDC groups. Membership of this group overlaps into the SAG providing continuity within these groups and to the overall direction of the study effort. This group is key to the direction of effort in systems development in support of the CONAF study.

e. Research Analysis Corporation/Study Advisory Group. The chairman of the RAC/SAG is a representative from the Concepts and Force Design (CONFOR) Group, USACDC, with representation from SAG, USACDC, HQ, USACDC; and DA staff agencies. The RAC/SAG serves as the principal advisory group to the contractor in guiding his efforts in support of the study.

Section III. BACKGROUND AND SPECIFIC METHODOLOGY

6. DEVELOPMENT GUIDELINES.

a. To establish general guidelines for development of the methodology, considerable research was done to identify major weaknesses in the current

force structure study program. Of principal concern is achieving the capability of coordinating and collating the voluminous data derived from the many studies relating to and impacting on force development. Another concern is the capability of using this information for the conduct of in-depth analyses to provide timely and properly integrated data and results to assist the DA staff in arriving at logically supported force structure decisions.

b. To achieve any acceptable degree of responsiveness, the methodology obviously had to include maximum computerization where possible. Before developing new computer programs and models, numerous existing capabilities were examined. This examination revealed that a number of existing programs and models were suitable as is or they could be modified to support the methodology. This substantially reduced the number of new program and model developments required. Those programs and models selected from the existing inventory and newly developed capabilities are discussed in detail within the appropriate section of the methodology.

7. METHODOLOGY FLOW DIAGRAM. Figure 1-1 depicts CONAF methodology flow diagram. The discussion of the methodology is keyed to lettered blocks on the flow diagram. (Figure 1-1 is a foldout chart on page 1-13)

8. INITIAL INPUT DATA (BLOCK A):

a. On receipt of the initial DA CONAF phase I study directive, USACDC and the DA staff agencies identified documents for the formulation of a study data base. Appropriate portions of the data base provided the US objective and strategy; Army missions; intelligence estimate; operational concepts; fiscal, logistic, and manpower constraints; and available materiel systems.

b. Using the above data, the environment was examined and environmental assumptions were developed for the period of the study to include those factors most likely to exert an influence on the size, organization, and functions of the future Army.

c. The environmental factors were further analyzed along with US objectives, strategy, and intelligence estimates and potential conflict situations developed. These were coordinated with the Deputy Chief of Staff for Military Operations (DCSOPS), and scenarios were prepared to support key areas of interest to the DA staff.

d. At the conclusion of the analysis described above, the results were collated. Together with additional assumptions developed by USACDC they were forwarded to DA for approval. The DA response to this document provided the approved study guidance for continuation of the study.

e. In future iterations of the CONAF methodology, the depth of these preliminary analyses will be predicated on the degree of change projected within the areas discussed. The SAG provides changes in these areas as they occur for incorporation into the study. The significance of the changes will dictate where the methodology will be entered and recycling will be required.

9. DEVELOPMENT OF CONCEPTS AND ALTERNATIVE DESIGNS (BLOCK B):

a. Based on the results of the analyses described in paragraph 8 above and the approved DA guidance, alternative strategic operational concepts were developed for execution of the national strategy. The concept statements express alternative solutions in which the threat might be met within a specific environmental constraint with the threat analysis and strategy. Concept statements were developed for the following components of the force structure:

(1) European Based Force.

(2) CONUS Based - European Reinforcing Force Strategic Reserve.

(3) Pacific Based Force (less Special Mission).

(4) Special Mission Force, Korea.

(5) Special Mission Force, Vietnam.

b. The alternative concept statements were then presented to the CONAF SAG for selection of those for which alternative force designs were to be developed (block E).

c. Concurrently with the development of alternative concept statements, the USACDC SAGP developed the cost methodology and conducted an extensive analysis of the cost and resource constraints provided by DA (block C). Results of this analysis were then provided to CONFOR Group in the form of available and projected materiel assets and a detailed breakout of dollar constraints by appropriation category. Also, at this time, SAGP effected coordination with the DA ACSFOR to obtain the baseline force. Subsequently, in coordination with CONFOR Group, SAGP prepared the modernization plan for submission to DA for approval. SAGP also conducted a review of numerous computer models to determine their potential application in the CONAF methodology.

d. Following SAG selection of alternative concept statements, USACDC began development of alternative designs within concepts. As CONFOR Group began to develop broad alternative designs, other USACDC group and agencies began to formulate alternative conceptual doctrine and organizational structure within their areas of proponency.

e. Recognizing the wide range of possible alternatives within each concept and that all likely alternatives must be explored, a computer assist program (LP Program) was developed that would permit a rapid, yet extensive consideration of most feasible alternatives. As force missions evolved from the analysis of the military nature of the potential enemy and the concept, many materiel mixes were examined which fell within personnel and monetary constraints. Section IV contains a detailed description of the LP Program, analysis of program output, and conversion of the output to combat elements of a force structure, e.g., maneuver battalions, brigades, and divisions.

f. The data bank from which units/organizations were selected to structure the combat elements of the force contained G-H-T series units, Army Strategic and Tactical Reorganization Objective (ASTRO) organizations, combined arms concepts, and new units developed by USACDC groups and agencies such as the dynamic infantry division and separate brigades.

g. The broad alternative designs developed were then presented to the SAG for selection of designs to be retained for further refinement and evaluation (block E).

h. The broad alternative designs selected by the SAG, along with functional area constraints, were provided to USACDC groups and agencies for fleshing out the remaining portion of the alternative force design structures. Groups and agencies insured that designs conformed to existing or conceptual doctrine, provided organizational structure in proponent areas within constraints, and recommended new units, as appropriate, to accomplish the mission. A degree of latitude was given to groups in adjusting constraints between functional areas for which they had proponency. In CONAF phase I, the fleshing out of alternative designs was accomplished manually. For future iterations of CONAF, plans provide for use of the modular force planning model (battalion slice model) for the detailed fleshing out support requirements for alternative designs. Use of the battalion slice model will enable the designer to provide groups and agencies with complete detailed force structures for review, thereby substantially reducing the time element involved. Although the battalion slice model has numerous shortcomings in dealing in conceptual doctrine, organization, and units, refinement of the model to improve its usefulness would be much simplier than to refine other models or to develop a new one. For CONAF purposes, the major shortcomings of the model are a data base limited to existing TOE units equipped with current inventory materiel, limited to TASTA-70 organizational concepts, and, in some subroutines within the model, containing what appears to be inflated data from which support requirements are derived. Planned refinement includes updating and expanding the data base to include conceptual units and organizational concepts. When refinement to the battalion slice model are completed, the designer, using the LP program, the LP/BSM interface model, and the BSM, will be able to develop and analyze numerous alternative designs in detail and within dollar and resource constraints. As new conceptual organizational doctrine and units are developed, they must be incorporated into the data base of these models.

i. Of particular importance in the model refinements is insuring that model outputs interface with costing and resource analysis methodology models and force effectiveness evaluation models.

10. COARSE ANALYSIS, ALTERNATIVE FORCE DESIGNS (BLOCK F):

a. During development and refinement of the alternative type force designs within each concept, work continued in preparation for the force effectiveness evaluation of each alternative and the baseline force. For CONAF phase I, this included development of the CONAF Evaluation Model (CEM), preparation of evaluation of Blue scenarios by USACDC, preparation of the Red scenarios by Assistant Chief of Staff for Intelligence (ACSI), Intelligence Threat Analysis Detachment (ITAD), and transmission of data for evaluation.

b. Chapter 3 contains the background, development, general description, and proposed refinements of the CEM.

c. As the alternatives were being fleshed out, detailed Blue scenarios were developed to include the general and special situations. General scenarios were prepared for each concept, and special situations, including initial deployment of forces, were prepared for each alternative. The concept scenarios were presented to the SAG for approval.

d. Following SAG approval of the Blue scenarios, the scenarios with the complete force description were sent to the ITAD, ACSI, DA. ITAD prepared the Red scenarios and the Red planner data for conduct of the force evaluations. When the scenarios were completed and the alternatives within a concept were fleshed out, the package was delivered to the contractor for force effectiveness evaluations.

11. ANALYSIS OF COARSE EVALUATIONS (BLOCK G):

a. Reference, RAC CONAF Report, dated December 1971, consisting of the following volumes:

(1) Volume I -- A general summary of the entire project with a nontechnical description of what was undertaken, what was accomplished, and what remained to be done.

(2) Volume II -- This volume is a complete description of the RAC portion of the CONAF Force Evaluation System. It is a methodology volume that describes the organization and operation of the CEM, the derivation of values for input parameters and variables used therein, and the procedures used to accomplish the auxiliary analyses.

(3) Volume III -- Contains descriptions of the CONAF forces simulated and analysis of how and how well the differences in the various forces were differentiated by the CEM and in the auxiliary analyses.

(4) Volume IV -- Describes desirable improvements to the CONAF Force Evaluation System which could not be made during work year (WY) 1971.

b. Briefly, the purpose of the CEM is to develop quantitative and qualitative measures of the degree to which alternative force designs could perform the functions of land combat. The CEM is a fully automated combat simulation with commander's decisions simulated at every headquarters level, and combat reduced to brigade level. The model outcomes are sensitive to the mixes of battalions and resource expenditures on both sides. The main function of the CEM is to generate engagement situations for which outcomes are determined and translated into two results: forward edge of the battle area (FEBA) movements and state degradation. The play of each force develops time histories of the FEBA movement, average status of all forces, supplies or resource units consumed, distribution of maneuver unit participation by type of support, casualties, and type and average strength of enemy forces. Examination of these results make some distinction discernible among the forces, representative of the force characteristics, and may influence subsequent engagements. The CEM can be used to simulate theater-wide nonnuclear war that has a continuous FEBA; and in about 10 seconds of computer time, a theater day can be simulated.

c. USACDC received the RAC analysis of concept I and II alternatives on 30 November 1971. Since this initial report was to be used for comparative analysis of the alternative forces, considerable time was required in determining key factors to be used for comparison and the degree of credibility of each. This was accomplished with assistance from RAC.

d. An analysis of the RAC CEM runs shows that the most logical combat effectiveness indicators to be FEBA trace in terms of time versus distance; the status of both Blue and Red forces at a given time in a battle; and the supply consumption factors of the Blue forces which are derived from resource units available versus resource units required. This model proved sensitive to the application of different levels of resource units. Casualties also are indicators and, although they may be suspect as now portrayed, they do reflect interesting comparative trends.

e. Indicators were found to be rather good comparisons of force effectiveness; however, some major limitations also were found. These limitations are the inability to advantageously employ the attack helicopter and the inability to play true Red doctrine (echelonment of Red forces), which detracts from the plausibility of Blue effectiveness against the Reds. Resource units can be an excellent indicator of force effectiveness, if improved on. A method is necessary to differentiate more finitely between classes of supplies and to play personnel replacements more discretely. Another item is the

inability to play barrier and denial capabilities and weigh their contribution to force effectiveness. Lastly, the CEM does not play vertical envelopments and airmobility; therefore, alternative designs weighted heavily with their capabilities suffer when compared with other forces.

f. Results of the cost and resource analysis described in chapter 2 and the CEM capabilities, limitations, and evaluation indicators then formed the basis for the comparative force analysis. The unmodernized and modernized baseline forces were used as the standard for comparison of alternative designs.

g. Results of the analysis then provide the supporting rationale and recommendation for preferred alternative force designs within concepts. The recommendations with supporting rationale were then presented to the CG, USACDC, for selection of designs for retention and presentation to the SAG. An initial report is then prepared for submission to the SAG (block I). On the basis of the initial report, the SAG selects those alternative force designs for retention and further analysis.

12. SPECIFIC DETAILED EVALUATIONS AND ANALYSIS (HIGH RESOLUTION WAR GAME) (BLOCK L):

a. Not available for use in the methodology during CONAF phase I is the high resolution wargame or sometimes referred to as the "middle model." Although development is not completed, the division wargame model (DIVWAG) appears to be the most appropriate model for this purpose. The DIVWAG model will examine division forces and provide insights as to the contribution that they make to the overall force effectiveness. DIVWAG will provide quantitative insights into the relative effectiveness of divisions equipped with various mixes of weapon systems. It also will examine competitive operational concepts at the division and the brigade levels.

b. The DIVWAG model probably will be used to determine impact of trade offs in weapon mixes, develop insights useful to proponent agencies and groups for basic unit design, and insights useful in development or refinement (or both) of new tactics and/or concepts of support. Insights derived from this model may be useful in refining the CEM. It may be desirable to recycle forces through the CEM with modifications resulting from DIVWAG findings to determine the impact on theater forces.

c. A detailed analysis (block M) of the results of a high-resolution wargame is then conducted. Results of this analysis may necessitate reexamination of trade offs, a detailed cost examination, and minor redesign of units to reflect approved trade offs and mixes. If no further evaluation is required, a final report is prepared (block O) for submission to the SAG (block P).

Section IV. DEVELOPMENT OF BROAD ALTERNATIVES

13. PURPOSE. This section contains a detailed description of the techniques used in development of broad alternative type-force designs.

14. GENERAL. Recognizing the wide range of possible alternatives within a concept and that all likely alternatives must be explored, a method had to be developed that would enable the designer to rapidly examine most feasible alternatives. To assist in the development and examination of alternatives, a linear program was used to address materiel, personnel, and dollar mixes. The linear program was not used in the normal sense of total optimization. Rather, it was designed to optimize within categories of systems, e.g., tanks, and does not optimize between categories, e.g., tanks and aircraft. In some instances, by constraining a majority of the variables, it merely provided a method of rapid calculations of stated mixes for a determination of feasibility based on overall constraints (materiel, personnel, and dollars). The program and the techniques for its use were presented to the CEAG and were accepted by them. A detailed description of the program, derivation of the factors used, and the techniques of examining alternatives are contained in the following paragraphs.

15. COMPUTER PROGRAM:

a. The program as originally developed contained five categories of equipment consisting of tanks, attack helicopters, antitank missiles, tube artillery, and missile artillery. The tank category contained five systems (XM803/New MBT, M60A1E2, M60A1, M60A1 retrofit, and M-551); the attack helicopter, the AH56 and Cobra with TOW; and antitank missiles, Dragon and TOW; the tube artillery (155-man and 8-inch); and missile artillery, the Lance. Because of current inventory, projected assets, and new buys, these 13 systems required 18 system entries in the program.

b. Specific factors were developed for each system for consideration in the program. They are the number in current inventory, personnel cost per system, dollar cost per system, and an index of firepower potential (IFP) differentiated as antitank (AT) and antipersonnel (AP).

c. Derivation of factors:

(1) The current inventory assets were provided by the USACDC SAGP. These figures were derived from an analysis of current documents in close coordination with the DA staff in order to identify that quantity of each system available to the Army in the field.

(2) In identifying the personnel costs per system, results were used from an extensive analysis of numerous type force structures, e.g.,

baseline force, Echelons Above Division, Army Strategic and Tactical Reorganization Objective (ASTRO) Study, European Force Design Study, battalion slice model, etc. Comparison of those results determined that reasonable approximations could be made using the results of modified runs from the battalion slice model. The personnel support factor represents that number of personnel required in theater to support a single system (e.g., tanks). The factor includes the system crew and all other support back to the water's edge. The factor derived from the battalion slice runs was considered that required for sustained operations or 100-percent support. The 100 percent was further broken out into percentages by functional areas, all of which are variables and were varied during the numerous runs to get a feel for the impact of these changes. For final runs of desirable alternatives, the factors were changed to coincide with the higher echelon operational concept envisioned for the alternative.

(3) The per system dollar costs were provided by the USACDC SAGP and were concurred in by the Office of the Comptroller of the Army (OCA).

(4) The IFP was derived from the theater combat model (TCM) developed by the RAC. Those systems for which the TCM contained no IFP were computed, based on the formula contained in the TCM report.

(5) The major threat was considered armor; therefore, the initial systems selected for the model primarily are armor defeating. When the program is refined, as a minimum, it will contain those systems reflected in the Program Objective Memorandum (POM) and those identified by the Materiel Program Priorities Review Committee (MPPRC). Not all systems or program activities will have or will require IFPs and personnel support factors; however, quantities and dollar value for these are particularly significant in examining the entire list. Expanding the program will enable the designer to derive some insights as to the impact of trade offs early in the design development stage. The principal advantage of the program is the rapidity with which numerous useful analyses can be accomplished. The specific factors used have been omitted as they are all variables and were altered in many computer runs.

16. USE OF THE COMPUTER PROGRAM:

a. Before the program was used, considerable judgment obviously would be required to develop logical input and to conduct a useful analysis of the output. Personnel working with the program had considerable experience in previous force structure studies and their evaluation. This experience plus extensive research of many other force structure studies and evaluations enabled the user to become familiar with the possible potential of particular materiel and personnel mixes. The dollars constraint kept them within reasonable cost limitations.

b. Based on the background above, the input was prepared for numerous computer runs. The input required for the program is identified in terms of percentage of armor, mechanized infantry, attack helicopter, and artillery forces. The percentage represents that percentage of personnel within the total force structure oriented to the support of one of the operational functions. Also required were total force personnel constraints, dollar constraints, and system selection. System selection refers to identifying a specific number of any system desired or permitting the program to optimize within system categories.

c. The output consists of a listing of the number of systems by type, total dollar cost identified by system, personnel costs reflected by functional areas and totals, and the total IFP. An initial analysis is made at this point to identify nonviables. At this stage, they primarily consisted of those that exceeded constraints, some that appeared militarily unacceptable, and those that reflected totally unacceptable product improvement or modernization. An example is a buy of 50 new MBT that would not warrant conversion of a production line. However, the nonviables were retained to answer "what if" questions. In CONAF phase I, planners tried to develop alternatives that consisted of substantially different mixes from those of the baseline force yet appeared more combat effective. This was done to gain insights from the course effectiveness evaluations of potentially promising variations for further refinement and evaluation in future phases of CONAF.

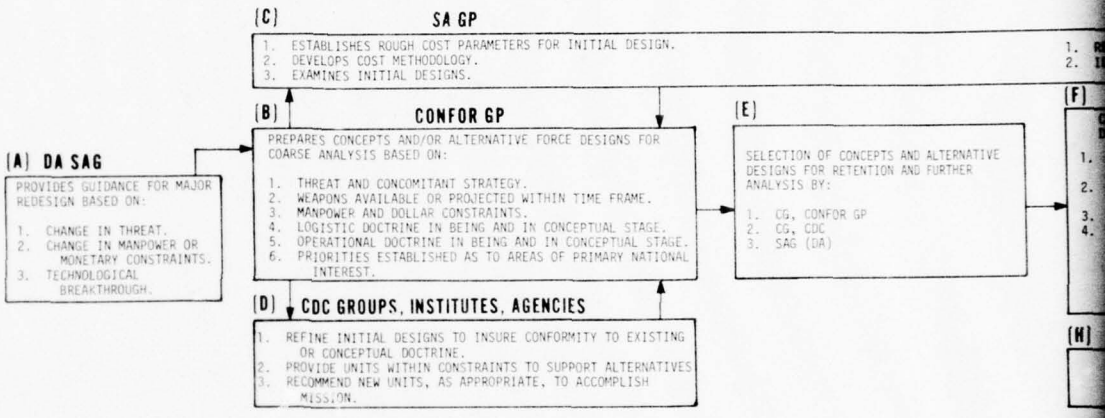
d. Those alternatives retained from the above described screening were either reruns following desired changes or retained for fleshing out. Changes for reruns included certain rebalancing options such as varying force ratios, increased mobility, improving modernization within or between categories of systems, altering personnel support factors, etc. The initial runs were oriented principally to the European Based Force; however, at this point, reruns were prepared to examine the European Based Force and the European Reinforcing Force combined. Additional runs were made to examine the total Active Army division force structure (European Based, European Reinforcing, Strategic Reserve, and Pacific Based). An analysis of these reruns led to discarding some that became infeasible and changing others. Further, judgment had to be drawn as to priorities for modernization within the force structure. On completion of these runs, alternatives selected for retention are considered candidates for further development and analysis. These alternatives are then fleshed out (combining personnel and equipment into units).

e. The data bank of units and organizations used for fleshing out designs consists of G-H-T series, ASTRO, combined arms, dynamic infantry, and other new unit designs derived from other studies or provided by USACDC groups and agencies. In CONAF phase I, this process was accomplished manually. It appeared that the process was suited to automation; therefore, the USACDC SAGP began to develop a model that would provide an automated data bank

and would be able to use input or the output from the computer assist program. As new unit designs are developed, they will be added to the data bank to provide a rapid means of fleshing out the combat elements of a design. The data bank for this model will interface with the battalion slice model.

f. In fleshing out a design, the surveillance force was formulated first, followed by the fighting and fixing force, fire support, combat support, and combat service support. As the fleshing out progresses, the design is continually scrutinized for ways of increasing effectiveness. This has been previously referred to as rebalancing options. Again, it may be desirable to vary the percentage of armor versus mechanized infantry, the airmobile weapon systems to ground mobile in an effort to improve mobility, maneuverability, and flexibility of the combat force package. The fire support and combat service support ratios may be changed. The impact of these changes can be readily determined using reruns through the computer assist program.

g. At this stage of design development in CONAF phase I, the analysis of command, control, and communication; intelligence; and logistics was accomplished by comparing personnel strengths within functional areas to other force structures developed, employing similar concepts and doctrine. Refinements to the battalion slice model described in chapter 1, to include expanding the data, should permit an in-depth analysis of support requisites.


(C) SA GP
1. ESTABLISHES ROUGH COST PARAMETERS FOR INITIAL DESIGN.
2. DEVELOPS COST METHODOLOGY.
3. EXAMINES INITIAL DESIGNS.
(B) CONFOR GP
PREPARES CONCEPTS AND/OR ALTERNATIVE FORCE DESIGNS FOR COARSE ANALYSIS BASED ON:
1. THREAT AND CONCOMITANT STRATEGY.
2. WEAPONS AVAILABLE OR PROJECTED WITHIN TIME FRAME.
3. MANPOWER AND DOLLAR CONSTRAINTS.
4. LOGISTIC DOCTRINE IN BEING AND IN CONCEPTUAL STAGE.
5. OPERATIONAL DOCTRINE IN BEING AND IN CONCEPTUAL STAGE.
6. PRIORITIES ESTABLISHED AS TO AREAS OF PRIMARY NATIONAL INTEREST.
(A) DA SAG
PROVIDES GUIDANCE FOR MAJOR REDESIGN BASED ON:
1. CHANGE IN THREAT.
2. CHANGE IN MANPOWER OR MONETARY CONSTRAINTS.
3. TECHNOLOGICAL BREAKTHROUGH.
(D) CDC GROUPS, INSTITUTES, AGENCIES
1. REFINE INITIAL DESIGNS TO INSURE CONFORMITY TO EXISTING OR CONCEPTUAL DOCTRINE.
2. PROVIDE UNITS WITHIN CONSTRAINTS TO SUPPORT ALTERNATIVES
3. RECOMMEND NEW UNITS, AS APPROPRIATE, TO ACCOMPLISH MISSION.
(E)
SELECTION OF CONCEPTS AND ALTERNATIVE DESIGNS FOR RETENTION AND FURTHER ANALYSIS BY:
1. CG, CONFOR GP
2. CG, CDC
3. SAG (DA)
(F)
(H)

CONAF METHODOLOGY

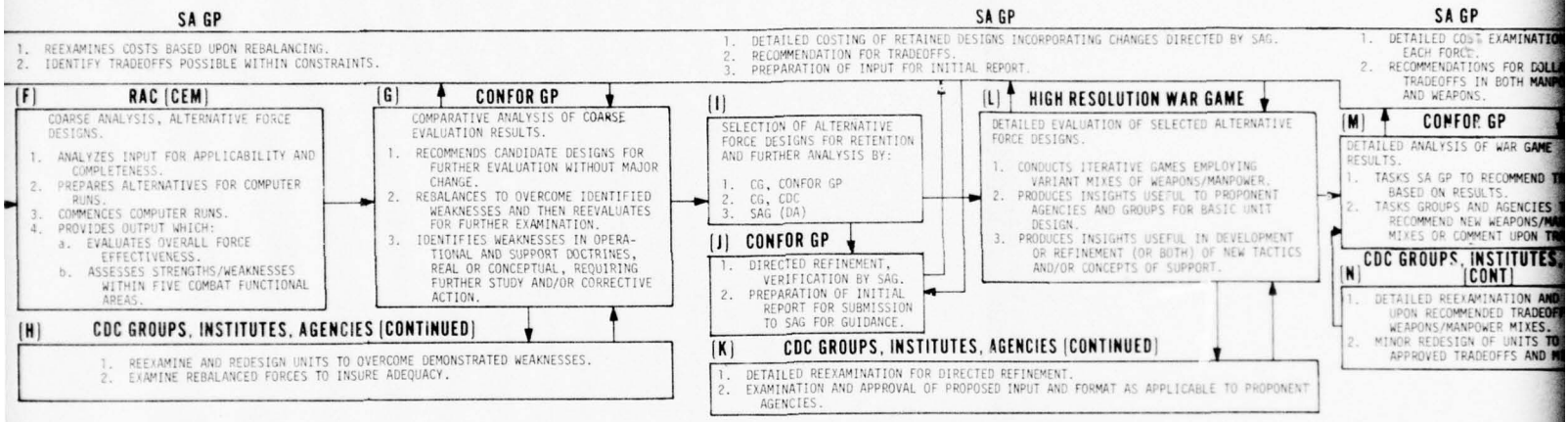


Figure 1-1 — CONAF m

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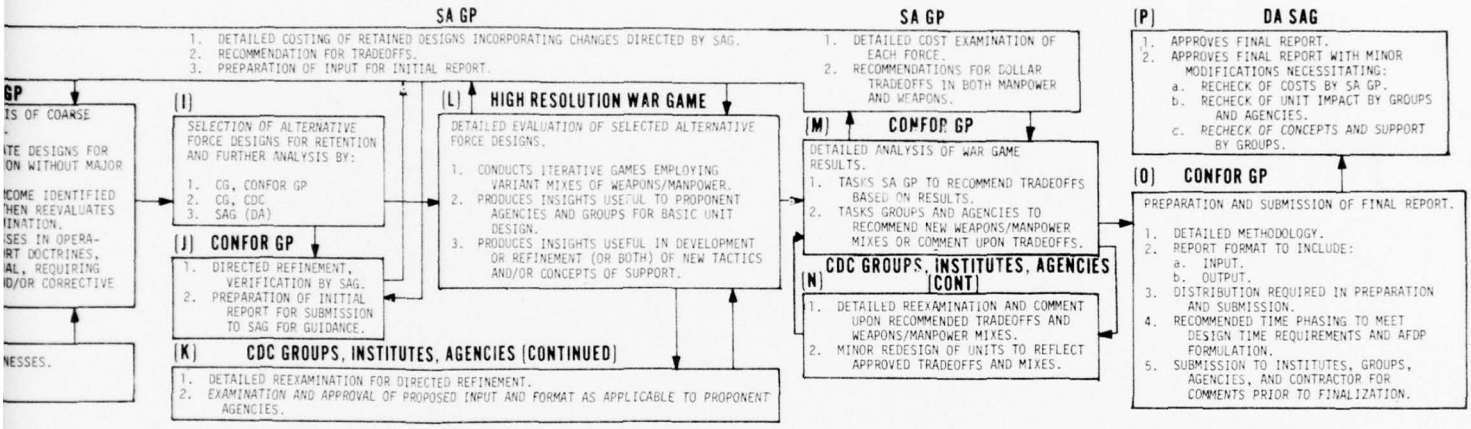

Figure 1-1 — CONAF methodology (U)

3

CHAPTER 2

COST AND RESOURCE ANALYSIS METHODOLOGY

Section I. BACKGROUND

1. GENERAL:

a. USACDC Functional Reorganization Impact on CONAF. As USACDC and HQ, DA began the preparation of the CONAF directive, other actions were ongoing within USACDC to ammend and revitalize the combat developments process. Long-range requirements, initially the major focus of combat developments, were yeilding to realistic economic constraints applied to the planning time period (2-10 years). Testing, materiel needs statements, and study priorities are among other changes that have appeared along with the development of a USACDC capability in costing. Accordingly, the methodology described in the following paragraphs covers perhaps more than the CONAF study alone would require. The methodology was planned, developed and implemented for:

(1) Meeting CONAF requirements.

(2) Assisting USACDC groups and agencies to determine resource implications of combat developments.

(3) Providing to USACDC and to the HQ, DA staff a medium for discussing combat developments in terms of the planning, programing, and budgeting system (PPBS).

b. Unprecedented costing requirements. There was little experience available to USACDC in initiating the costing effort; there were few, if any, precedents for costing on the scale envisioned. The development of the methodology was essentially a pioneer approach because there was no "road map." There was misgiving at both HQ, DA staff, and USACDC levels that the effort could be accomplished. In September 1971, USACDC reported to the CONAF cost subcommittee that the methodology had been developed, tested, and established as a successful tool for meeting the purposes stated above.

c. Future Efforts. At the time of this report, some of the procedures need to be automated and a few problems exist in obtaining OMA (operations and maintenance, Army) costs under changing relationships. On the whole, the cost comparisons appear valid, and the resource constraint methodology seems to be realistic. The difficult task of developing PEMA (procurement of equipment and missiles, Army) plans was simplified for USACDC by

the timely and comprehensive assistance of the Weapons Systems Analysis Directorate, Office of the Assistant Vice Chief of Staff and the Directorate of Cost Analysis, Office, Comptroller of the Army (OCA).

d. General Cost and Resource Methodology. This chapter describes the methodology used in the CONAF cost and resource analyses. There are two parts. The first is a cost comparison of initial and operating costs for forces and force "packages" (European Based, European Reinforcing, Strategic Reserve and Pacific). The second is the annual resource requirements with appropriate schedules within annual constraints. The methodology for conducting the analyses comprises a combination of the activities shown in figure 2-1. The activities are discussed below.

(1) Background information plays an important role in the manner in which a study is conducted. The background information that was pertinent to this study included the study directive and accompanying tasks, the study assumptions, and the study constraints and guidance. All of these are considered in the remainder of this section.

(2) The next major item of concern in the analysis was the selection of computerized models that could be used most effectively for force costing and force planning. After a review of possible models, the COSTALS (Cost and Analysis System) Model was chosen for force costing and the battalion slice model was selected for force planning. These and other models are summarized in section II and discussed in detail in appendix A.

(3) The study input data are considered in section III. These data are divided into three categories: materiel, personnel, and cost factors. The discussion on materiel and personnel data is primarily concerned with sources. The discussion relating to cost factors indicates why such factors are needed.

(4) Utilizing the necessary background information and input data with the proper model and the various CONAF design forces, it was then feasible to perform the initial cost and resource analyses. The methodology of the cost analyses (including cost comparisons) is considered in sections IV, V, and VI of this chapter. These sections consider the baseline force,[1] conceptual forces, and civilian and reserve components, respectively.

(5) An equal-cost methodology was applied to the conceptual forces. (A detailed discussion of equal-cost forces is presented in section VII of this chapter.) The forces were considered to be equal-cost forces if two criteria were met:

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[1]The baseline force is a force selected from the Army Force Development Plan (AFDP), 1 July 1975, and modernized to 1982. It contains division forces (of the Army in the field) which are assigned to the four force packages under consideration in the CONAF study.

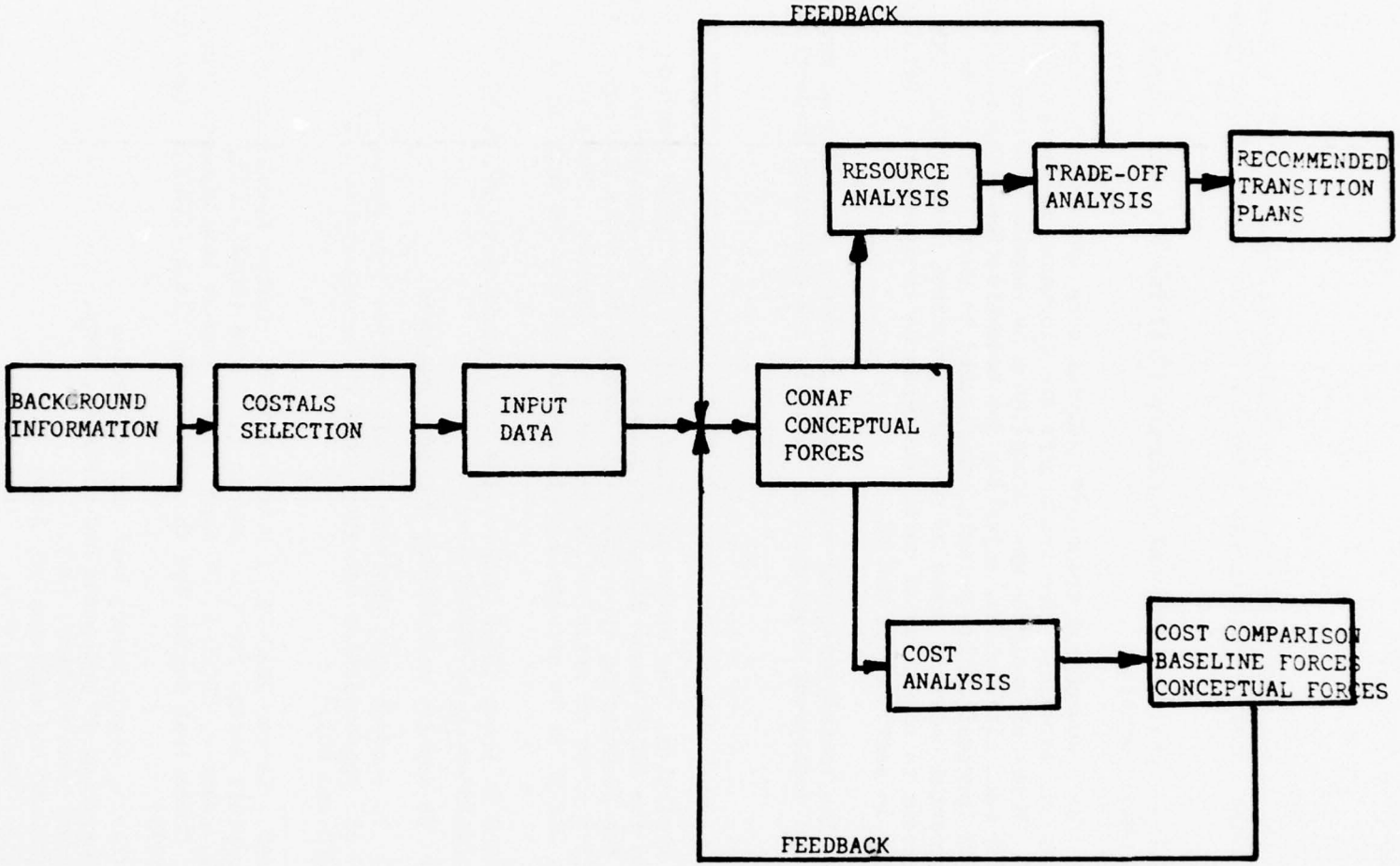

Figure 2-1--Flow chart of cost and resource analyses

(a) Comparative costs were approximately equal for the forces evaluated in the combat effectiveness appraisal by the Combat Effectiveness Model (CEM).

(b) Total obligational authority (TOA) for the total forces were approximately equal.

(6) The resource and trade-off analyses were addressed to both organizations and materiel. The trade offs are discussed in section IX, paragraph 3. Materiel analysis was accomplished by summing materiel by line item for each alternative, adjusting for modernization as appropriate, adding POMCUS (prepositioning materiel configured to unit sets) and determining incremental costs in terms of military personnel, Army (MPA), OMA, and PEMA factors to obtain total costs and resource requirements. Details are presented in sections VII and IX.

(7) The transition-plans-methodology considers a melding of materiel, personnel, and deployment requirements. Details are presented in section X.

2. TASKS:

a. DA Directive. The Assistant Chief of Staff for Force Development (ACSFOR), in the CONAF study directive, tasked USACDC to develop analytical procedures for formulating type forces and analyze the costs and capabilities of alternative mixes of organization and materiel systems. Using the above procedures, USACDC is to provide a preferred design for the Army in the field.[2]

b. USACDC SA Group CONAF Tasks. The CONAF tasks assigned to USACDC Systems Analysis Group by USACDC are:[3]

(1) To develop methodology for cost analysis.

(2) To conduct cost analyses of alternative type force designs in terms of all appropriation category costs where applicable (RDTE, PEMA, MCA, OMA, MPA and RC).[4]

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[2]USACDC, ICAS. Letter ICAS-DA, 1 November 1970. Combat Developments Study Plan: Conceptual Design for the Army in the Field (CONAF) (U).

[3]HQ, USACDC. Letter, CDCCD-F, 27 April 1970. Combat Developments Study Directive: Conceptual Design for the Army in the Field (CONAF). (and change 2, 1 June 1970)

[4]RDTE - research, development, test and evaluation.
PEMA - procurement of equipment and missiles, Army.
MCA - military construction, Army.
OMA - operations and maintenance, Army.
MPA - military personnel, Army.
RC - Reserve components.

c. Additional Tasks Later Assigned to SA Group. The USACDC SA Group was tasked to assist the USACDC Concepts and Force Design (CONFOR) Group with the following:

(1) The conduct of trade-off analyses between appropriation categories subject to overall dollar constraints.

(2) A comparison of a current representative force extracted from the Army Force Development Plan (AFDP) 1972-1983 with the preferred type force designs on a cost basis.

(3) A determination of the resource implications of designer recommendations.

(4) A determination of possible trade offs between modernization and product improvement.

d. Expansion of Methodology. In September 1970, the CG, USACDC, approved the inclusion of additonal tasks taken from the DA CONAF directive. These tasks pertained to the expansion of the methodology to provide for a closer intergration of combat developments planning with force development activities[5] and the identification of priority tasks for the HQ, DA staff in implementing a preferred design. These tasks were to be accomplished through the medium of the planning, programing, and budgeting system (PPBS).

3. COST ANALYSIS ASSUMPTIONS AND PRINCIPLES:

a. Assumptions:

(1) A peacetime environment was assumed for the purposes of the cost analysis.

(2) RDTE and MCA costs were similar in design and were not considered in the analysis.

(3) Those units in the baseline and conceptual forces considered nearly equal to current G, H, and T series table of organization and equipment (TOE) units were costed using data from the COSTALS data base.

(4) For conceptual units that were considered similar to existing units, cost estimates were based on the costs of units in the COSTALS data base. Incremental costs for materiel and modernization of equipment were added to the cost for the basic conceptual unit.

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[5]HQDA. Letter FOR-DS-DC, 17 April 1970. Conceptual Design for the Army in the Field (CONAF).

(5) The current baseline force will have been modernized to the extent that new materiel will be available by 1982.

(6) Movement capabilities are assumed to be sufficient to move Army units from CONUS to other theaters. Each design within a concept moves similar type units; thus deployment costs were assumed to be equal. Consequently, no costs are included for transporting forces to Europe.

(7) Civilian manpower requirements were calculated to support the Active Army divisional force units on an austere basis. Base operations, general support forces, and special mission force requirements were not included. The assumption incorporated in each design of CONAF is that support requirements are reduced and, therefore, civilian personnel requirements can be decreased.

(8) Delivery of equipment will begin in the year following purchase.

(9) Special mission and general support forces on the ground in Europe were derived from the AFDP troop list for 1972-1982. The structured strength for these forces is assumed to continue at a constant level through the CONAF period (1982). Modernization equipment requirements for these forces consist primarily of air defense (AD) and Army Security Agency (ASA) items of equipment. These forces are further assumed to be structured identically in all designs. Consequently, comparative costs were not developed. However, personnel, materiel, and dollar resource requirements were included in the resource analysis.

b. Principles:

(1) To the extent possible all Active Army units were costed at TOE level 1, fully equipped and manned.

(2) The cost estimates for conceptual units (based on unit reference sheets - URS) were based on cost factors derived from COSTALS cost data. Incremental costs for materiel and for modernization of equipment were added to costs for the basic conceptual unit.

(3) The computed costs are in constant FY 1972 dollars.

(4) Reserve units were costed at appropriate percentages of full COSTALS costs depending on the appropriation category (PEMA, OMA, MPA) of the Active Army units. The percentage factors were provided by OCA.

(5) For purposes of the cost analysis the European Reinforcing forces are stationed in CONUS.

(6) Based on guidance in the directive, costs were not discounted, inflationary aspects were not considered, and anticipated military and civilian real pay raises were not introduced into the study.

4. SUMMARY OF CONSTRAINTS AND GUIDANCE. Resource constraints have been established as a framework within which the cost analysis of the CONAF study was accomplished. These constraints and guidance applied to the CONAF Study originated from memoranda and directives issued by HQ, DA and USACDC.

a. Categories of Constraints. The constraints fall into three major categories: budgetary, manpower, and materiel. A detailed description of the constraints and limitations is available in volume I.

b. Additional Considerations. Additional considerations pertain to treaty obligations, location of forces, time constraints, reorganization of reserve components, and the time required to implement new plans in terms of the PPBS. These considerations are also discussed in volume I.

Section II. MODEL REVIEW AND SELECTION

5. INTRODUCTION. During the development of the cost and resource analysis methodology for the CONAF study, existing force-costing and force-planning models and methodologies were examined so that models could be selected and modified for use in the study. Several special runs were made for the study by the Major Item Data Agency (MIDA) utilizing some of their models. Materiel utilized from this agency is described in section VIII of this chapter. Nine other models were selected for detailed examination. They are discussed in appendix A. From these, the COSTALS Model was selected for the comparative costing of conceptual forces. A review of force-planning models was conducted simultaneously. This review culminated in the selection of the Modular Force Planning System (Battalion Slice) Model for force planning.

6. FORCE-COSTING MODELS. The nine models that were reviewed in detail for their usefulness in developing force costs are listed below. In appendix B is a check sheet that was used to evaluate each of the models.

a. Modular Force Planning System (Battalion Slice).

b. Force Cost Assessor (FCA).

c. Joint Strategic Operations Plan (JSOP) Model.

d. Cost Factoring System for Readiness Projection (COFACTS).

e. DOD Electric FYDP Model.

f. Electric FYDP/Mark Twain.

g. Resource Requirements and Precombat Capabilities (RECAP) Model.

h. Resource Related Planning System (RRPS - Dean Model).

i. Cost and Analysis System (COSTALS) Model.

7. FORCE-PLANNING MODELS. As indicated above, the battalion slice model was selected for force planning. This model was selected because it interfaces easily with COSTALS and can develop comparable support elements to provide a full division force equivalent (DFE). The Structure and Composition (SACS) Model was selected for use in force planning. Its use was limited, however, because it will not accommodate conceptual units or alternate TOE series.

8. NEW-UNIT COST MODEL. This model was considered at the time the costing procedures were being developed. It appeared to have much to offer in developing costs for new units or conceptual units which are comparable to existing units. It is complementary to COSTALS and has the potential capability of providing initial investment and annual operating costs rapidly. However, the New-Unit Cost Model must be updated to reflect the current revisions to the COSTALS Model. Appendix C has a detailed description of the New-Unit Cost Model as of April 1971. Many of the cost elements mentioned in appendix C have been superseded by different elements. Thus, they are no longer applicable.

Section III. INPUT DATA

9. INTRODUCTION. Data used as input in this study were obtained from a number of different sources. The principal sources are described below.

10. DATA ON MATERIEL. The USACDC costing effort for CONAF did not include calculating life-cycle costs of materiel items. These costs were obtained from several sources and subsequently approved by HQ, DA (OCA). Therefore, the costs and resource analyses are compatible with current PPBS activities of the HQ, DA staff.

a. Sources. Some of the most-used materiel sources were the Force Cost Information System (FCIS), the program objective memorandum (POM), the Army Force Development Plan (AFDP), tables of organization and equipment (TOE), and Department of the Army Supply Bulletin (SB) 700-20. These sources provided information from which cost factors could be developed for equipment used by the forces in the various designs. Additional data sources include the Selected Acquisition Reports (SAR) and the Weapons Systems Cost Data Handbook plus contributions from USAMC and the Comptroller of the Army (COA).

b. Allocation of Equipment. Equipment was allocated according to information developed by the designer in the form of unit reference sheets; CONAF Guidance from HQ, DA; and in TOE files created by USACDC. The URS identify conceptual units and their equipment.

c. Data base. A detailed discussion of the materiel data base and sources is in volume III.

11. PERSONNEL DATA. Information concerning personnel was derived from guidance and constraints discussed in volume I, chapter 3. The COA provided cost factors; HQ, USACDC Organization Directorate provided information relating to TOE; other cost factors were derived from the FCIS.

12. COST FACTORS DEVELOPED FROM THE COSTALS DATA BASE. To cost units that were not in the COSTALS or the FCIS system, cost factors were developed from the costs available in the COSTALS data bank. These factors were developed and used in costing non-COSTALS TOE/SRC units that are similar in type to those in the COSTALS data bank. A discussion of these factors is presented in section V of this chapter.

Section IV. BASELINE FORCE COSTING METHODOLOGY

13. INTRODUCTION. The baseline force for this study was developed using the Army Force Development Plan (AFDP) World-Wide Troop List which was produced by ACSFOR as the basic source document. Following purification of this troop list to make it representative of organizations planned for 1 July 1975, it was projected to 1982 and then submitted to ACSFOR and approved for use in the CONAF Study. Following approval, the individual units were related to comparable units in the COSTALS Model and then costed.

14. METHODOLOGY. Using the AFDP World-Wide Troop List as the basic source document, the following actions were taken to develop the baseline force.

a. Purification of Baseline Force List. A computer run and printouts were made of the units assigned to the Army in the field and expected to be based in Europe, those assigned to the European Reinforcing Force, those assigned to the Strategic Reserve, and those units expected to be based in the Pacific in 1975. The derivation and differentiation of these forces was accomplished through the use of the Army and Marine Corps Force Classification System for all units in each baseline force. Appendix D gives these descriptors. The use of these descriptors assisted in obtaining a computer printout from the US Army Management Systems Support Agency (USAMSSA) for each force. The AFDP reflected all currently projected changes in unit TOE including unit locations, activations and inactivations from the present through FY 1975. Because of this, it was necessary to examine each baseline force in the AFDP in detail, and to delete all units which would be inactivated or transferred out of the baseline force in this time frame. It was necessary to examine those units to be included in the

Triple Capability (TRICAP) Division field tests and to determine if those units would revert to their former baseline status following completion of the tests and, if they did not, to delete those units from the baseline force. The time frame for the TRICAP field tests (until 30 June 1975) is tentative and subject to change; consequently, some units may later be dropped from the baseline force if the units do not revert to their former status. Manpower constraints applicable to the CONAF study were applied to the resulting baseline force.

b. Materiel Modernization. The baseline force approved by ACSFOR received materiel modernization through 1982; the added materiel was calculated under CONAF constraints. These constraints included less PEMA monies than the program objective memorandum (POM) and the program decision memorandum (PDM) of September 1971 provide through 1977. Consequently, the CONAF Baseline Force of 1982 may be more constrained than the 1976 AFDP force.

c. Analysis of Baseline Force List. After analysis of the computer runs for each of the baseline forces, the TOE were compared with those in the data base for various computer costing models and those that were not included were identified with similar TOE in the model. These were then substituted and costed.

d. Exercising the COSTALS Model. After identification of these TOE, punch cards were prepared in the proper format for use in the COSTALS Model. After running of the model, the costs were adjusted, as required, and total costs for the forces were calculated. They are representative of the costs for 1976 in 1972 dollars.

e. Incremental Costing of Materiel Modernization Items. Concurrent with the above effort, a list was prepared of recommended modernization materiel items to be introduced into the baseline forces by FY 1982. These recommendations were based on the AFDP modernization equipment list, the Materiel Procurement Priorities Review Committee (MPPRC), modernization priority list and on the projected PEMA funds for new materiel procurement. The incremental cost for this new equipment was then developed for each TOE affected. These costs were added to the costs developed through use of the COSTALS Model. Following this, the costs for all units were aggregated. These costs are useful in comparing costs; however they are not applicable to the PPBS process. (These costs cannot be related to annual TOA.)

f. Matrices. The baseline force was used to develop matrices which could be used for comparison and analysis with the forces presented in the various alternatives to determine the degree of change in manpower and in materiel dollars by combat function. A discussion of these matrices is included in section VII, paragraph 24.

Section V. CONCEPTUAL FORCES COSTING METHODOLOGY

15. INTRODUCTION. The units that were developed for the various conceptual forces during the course of the CONAF study include units that are identical or similar[6] to existing TOE units and those known as no-match units. The identical or similar units were costed by using the COSTALS Model. The no-match units required other costing techniques. This section discusses the costing of the conceptual forces by COSTALS and non-COSTALS costing procedures. In addition, the costing of TDA units and incremental materiel is discussed.

16. COSTALS COSTING PROCEDURES. Since the COSTALS Model has been used extensively in the CONAF study to cost both the Baseline Force and those portions of the conceptual forces which are either identical to or comparable with TOE units in the COSTALS data bank, it is germane to provide a general description of the model. This description is followed by a listing of the elements which comprise the PEMA, OMA and MPA appropriation categories for initial investment and annual operating costs, and a discussion of the COSTALS costing methodology.

a. COSTALS description.[7] COSTALS is the primary component of the Army's Force Cost Information System (FCIS). The system provides costs for actual and hypothetical TOE units and for force structures such as theater forces, division force equivalents, and initial and sustaining support increments.

(1) Input. Input consists of SRC for actual force units. Hypothetical force structures are presently costed by modifying actual SRC. However, steps are being taken to make the future COSTALS data bank SRC-free, i.e., to permit costing a force from a list of its equipment and personnel.

(2) Output. Hard-copy output is available in a variety of formats. A conversational capability, via a cathode-ray tube (CRT) display device, permits analysts direct access to COSTALS. Such access makes rapid response possible on questions such as the aggregate costs of force structures.

b. Appropriation Categories. As used in the CONAF study, the COSTALS outputs were aggregated at the levels of initial investment and annual operating within the PEMA, OMA, amd MPA appropriation categories. Research and development and military construction costs were not considered.

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[6]Similar units are defined as those units which do not differ significantly from existing TOE units in function, personnel strength and type of equipment.
[7]Force Cost Information Fact Sheet, Comptroller of the Army, Dec 71.

(1) PEMA. The elements which make up the PEMA category for initial investment costs are major equipment, operational readiness float, repair-cycle float, repair parts, and accession and training. Similar PEMA elements for annual operating costs are major equipment, replacement repair parts, ammunition and missiles, and the PEMA portion of accession and training.

(2) OMA. OMA elements of initial investment costs are repair parts, minor equipment, station equipment, organizational clothing, Programs 4 and 7S, and the OMA portion of initial accession and training. OMA elements of annual operating costs are Programs 1 or 2, base operations, aircraft operations, Programs 4, 7M, 7S, 8M, 80, and 9, and the OMA portion of annual accession and training costs.

(3) MPA. MPA elements of initial investment costs are the MPA portion of accession and training, and initial permanent change of station (PCS) costs. Annual operating MPA costs are for accession and training, MPA excluding PCS, and PCS.

c. Detailed Description Reference. The makeup of each of the elements listed in the three previous paragraphs is summarized in appendix E and discussed in detail in section 2 of the Army Force Planning Cost Handbook. (1 Oct 1971)

d. Method of Costing. The TOE units were compared with the COSTALS data bank to insure that information on the TOE units was, in fact, contained in the data bank. The COSTALS Model utilized a data base of existing units, organized under G, H, and T series identified by standard requirements code (SRC). For each SRC the data base contains both personnel strength and unit-cost data.

(1) The COSTALS Model was employed directly for costing those units in the force that were identical to existing units. All TOE units in the force that could be identified as having an identical unit in the data bank were aggregated by the theater and force and then combined with other conceptual forces on master cards. The master cards were used to generate the COSTALS input cards. The personnel strength given for the TOE units in a conceptual force did not always agree with the authorized TOE strengths that appear in the COSTALS data bank. However, these strengths usually compared with levels 1, 2, or 3 as specified in the USACDC Pamphlet, Military Publications Reference Digest of Tables of Organization and Equipment. At the time that the COSTALS computer printouts were made in this study, only level 1 was included in the data base. Subsequently, COSTALS has bean modified to include data for other levels and these will be utilized in future analyses.

(2) A personnel ratio (PR) was developed to permit costing the forces at manned ratios for comparative purposes. This ratio was determined

by dividing personnel strength for a given TOE unit by personnel strength at level one. The ratio which was developed is as follows:

$$PR = \frac{CFPS}{CUPS}$$ (Conceptual Force Personnel Strength / COSTALS Unit Personnel Strength)

(3) The COSTALS Model was modified by the US Army Management System Support Agency (USAMSSA) at the request of the CDC Systems Analysis Group to apply the PR to certain man-related elements of the OMA and MPA appropriations. The formula for this modification is:

$$\text{COSTAL MPA (or OMA Factor)} \times \frac{CFPS}{CUPS} = \text{MPA (or OMA) factor for conceptual forces.}$$

(4) The elements of the PEMA appropriation category were not affected except for accession and training in which the personnel ratio is applied. All of the elements that are man related and would be affected by the PR are indicated by "yes" in figure 2.

17. NON-COSTALS COSTING PROCEDURES. A number of the units in the various CONAF concepts are either not identical to or comparable with current TOE units or are not contained in the COSTALS data bank. A technique was used to cost these units. The OMA and MPA costs were determined by comparative analysis of similar units in the COSTALS data bank. The PEMA costs were calculated from the actual equipment list in either the SRC or the URS in question. The cost for those units that could not be matched to a COSTALS SRC was stored on tape for use throughout the various conceptual forces. A sample of non-matched SRC was compared to SRC of the same nature in the COSTALS Model to determine whether the method employed was valid. Those units tested varied by less than one percent from the COSTALS sample.

a. Development of Cost Factors. The costing of non-comparable units was dependent on the development of suitable cost factors. To obtain those factors used in costing non-COSTALS TOE/SRC/URS, a representative sampling of TOE/SRC units that were similar in type was taken from the COSTALS data bank and averaged as identicated in figure 3. This method provided factors which are more definitive by type unit than could be obtained by calculating Army-wide averages.

(1) Total initial PEMA investments costs for costing non-COSTALS TOE/SRC and URS units were determined as follows:

(a) Major Initial PEMA Equipment Cost for TOE/SRC. Initially, materiel analyses of force packages were made using a data base of approximately 430 line item numbers (LIN). This data was compared to five typical divisions presented in DCSLOG Project No. DL 88, "DFE Cost Study, Force

INITIAL INVESTMENT COST	PERSONNEL RATIO APPLIED
PEMA MAJOR EQUIPMENT	NO
PEMA OPERATIONAL READINESS FLOAT	NO
PEMA READINESS CYCLE FLOAT	NO
PEMA REPAIR PARTS	NO
OMA REPAIR PARTS	YES
OMA MINOR EQUIPMENT	YES
OMA STATION EQUIPMENT	YES
OMA ORGANIZATION CLOTHING	YES
OMA PROGRAM 4	YES
OMA PROGRAM 7S	YES
OMA ACCESSION & TRAINING	YES
MPA ACCESSION & TRAINING	YES
PEMA ACCESSION & TRAINING	YES
MPA-INITIAL PCS	YES
TOTAL INITIAL PEMA	YES
OMA	YES
MPA	YES
TOTAL	YES

ANNUAL OPERATING COST	PERSONNEL RATIO APPLIED
PEMA MAJOR EQUIPMENT	NO
PEMA REPAIR PARTS	NO
PEMA AMMUNITION	NO
PEMA MISSILES	NO
OMA PROGRAM 1 & 2	YES
OMA BASE OPERATIONS	YES
OMA AIRCRAFT OPERATIONS	NO
OMA PROGRAM 4	YES
OMA PROGRAM 7M	NO
OMA PROGRAM 7S	YES
OMA PROGRAM 8M	YES
OMA PROGRAM 80	YES
OMA PROGRAM 9	YES
OMA ACCESSION & TRAINING	YES
MPA ACCESSION & TRAINING	YES
PEMA ACCESSION & TRAINING	YES
MPA, EXCLUDING PCS	YES
MPA, PCS	YES
TOTAL ANNUAL PEMA	YES
OMA	YES
MPA	YES
TOTAL	YES

Figure 2-2-- Application of personnel ratio to cost elements of COSTALS output

Item [a] - Methodology	Example: Field Artillery Units (Sample of Three Units) 105MM (Towed) SRC 06115G800	155MM (Towed) SRC 06165G600	175MM (Self Propelled) SRC 0645G700
1. PEMA, INITIAL			
A. Other PEMA (Op Read Float, Repair Cycle Float, Repair Parts, Accession & Tng)	$808,000	$975,000	$1,142,000
B. PEMA Total (Major Equip & Other PEMA)	$4,289,600	$4,526,000	$4,934,000
C. Factor, Other PEMA = A/B; Average Factor [b] .211	.188	.215	.231
2. PEMA, ANNUAL OPERATING			
D. Annual PEMA Cost (includes accession and training)	$334,000	$347,000	$300,000
B. PEMA Total, Initial	$4,289,699	$4,526,000	$4,934,000
E. PEMA Annual Factor = D/B; Average Factor .071	.077	.076	.061
F. PEMA Ammo & Msl Consumption	$362,000	$505,000	$328,000
G. Personnel Strength (SRC)	525	639	550
H. Ammo Factor $/man = F/G; Average Factor $692/man	$690/man	$790/man	$596/man

See footnotes at end of figure.

Figure 2-3-- Derivation of cost factors[c] (continued on next page)

Item [a] - Methodology	Example: Field Artillery Units (Sample of Three Units) 105MM (Towed) SRC 06115G800	155MM (Towed) SRC 06165G600	175MM (Self Propelled) SRC 06435G700
3. OMA, INITIAL			
I. Total OMA Initial	$640,000	$771,000	$662,000
G. Personnel Strength (SRC)	525	639	550
J. OMA Initial Factor $/man = I/G; Average Factor $1,210/man	$1,219/man	$1,207/man	$1,204/man
4. OMA, ANNUAL OPERATING			
K. Total OMA Annual	$763,000	$943,000	$922,000
G. Personnel Strength (SRC)	525	639	550
L. OMA Annual Factor $/man = K/G; Average Factor $1,535/man	$1,453/man	$1,476/man	$1,676/man
5. MPA, INITIAL			
M. Total MPA Initial	$1,393,000	$1,620,000	$1,385,000
G. Personnel Strength (SRC)	525	639	550
N. MPA Initial Factor $/man = M/G; Average Factor $2,568/man	$2,653/man	$2,535/man	$2,518/man

See footnotes at end of figure.

Figure 2-3--Derivation of cost factors[c] (continued)

Item [a] - Methodology	Example: Field Artillery Units (Sample of Three Units) 105MM (Towed) SRC 06115G800	155MM (Towed) SRC 06165G600	175MM (Self Propelled) SRC 06435G700
6. MPA, ANNUAL OPERATING			
O. Total MPA Annual	$3,025,000	$3,560,000	$3,085,000
G. Personnel Strength (SRC)	525	639	550
P. MPA Annual Factor $/man = O/G Average Factor $5,647/man	$5,762/man	$5,571/man	$5,609/man
7. OMA, INITIAL OVERSEAS			
Q. Total OMA Initial Overseas	$848,000	$1,075,000	$927,000
I. Total OMA Initial CONUS	$640,000	$771,000	$662,000
R. OMA Initial Overseas Factor = Q/I Average Factor 1.37	1.33	1.39	1.40
8. OMA, ANNUAL OVERSEAS			
S. Total OMA Annual Overseas	$1,161,000	$1,412,000	$1,343,000
K. Total OMA Annual (CONUS)	$763,000	$943,000	$922,000
T. OMA Annual Overseas Factor = S/K Average Factor 1.49	1.52	1.50	1.46

See footnotes at end of figure.

Figure 2-3--Derivation of cost factors[c] (continued)

Item [a] - Methodology	Example: Field Artillery Units (Sample of Three Units)		
	105MM (Towed) SRC 06115G800	155MM (Towed) SRC 06165G600	175MM (Self Propelled) SRC 06435G700
9. MPA INITIAL OVERSEAS			
U. Total MPA Initial Overseas	$1,664,000	$1,933,000	$1,656,000
M. Total MPA Initial CONUS	$1,393,000	$1,620,000	$1,385,000
V. MPA, Initial Overseas Factor = $\frac{U}{M}$ Average Factor 1.19	1.19	1.19	1.19
10. MPA ANNUAL OVERSEAS			
W. Total MPA Annual Overseas	$3,345,000	$3,933,000	$3,409,000
O. Total MPA Annual CONUS	$3,025,000	$3,560,000	$3,085,000
X. MPA Annual Overseas Factor = $\frac{W}{O}$ Average Factor 1.1	1.11	1.11	1.11

[a] Definitions:
(1) procurement of equipment and missiles, Army (PEMA).
(2) operations and maintenance, Army (OMA).
(3) military personnel, Army.

[b] Averages based on a sample of three of more SRC.

[c] Factors derived from data in COSTALS data bank.

Figure 2-3--Derivation of cost factors[c] (concluded)

Packages;" the results indicated that over 88 percent of the average of the major PEMA equipment were accounted for in this list. Costs were determined by applying cost data from SB 700-20.

(b) Other Equipment. Other equipment constitutes the difference between total initial PEMA and major PEMA equipment and includes the operational readiness float (ORF), repair cycle float (RCF) and repair parts (RP). Cost factors for "other" PEMA initial investment were determined by aggregating costs for each of the above categories for each of the SRC in the sampling. The percentage that "other" PEMA represents of total initial PEMA was computed by type unit.

(c) Total initial PEMA for TOE/SRC units. Total initial PEMA cost for TOE/SRC units was computed by aggregation of the sum of the major PEMA equipment by the cost factors discussed above.

(d) A list of major PEMA equipment items was given in the conceptual design URS. The cost was computed using cost data from ST 700-20 and summing.

(e) Total initial PEMA for URS Units. Total initial PEMA cost for URS units was computed by aggregating the sum of the major PEMA equipment cost and "other" PEMA cost as described before.

(2) The PEMA annual operating cost factor was determined by averaging the PEMA operating costs from a sampling of similar type TOE/SRC units.

(3) The PEMA ammunition/missile consumption factor in dollars per man-year was computed from known expenditures during annual service practice for similar type units and averaging.

(4) The OMA and MPA initial investment and annual operating cost factors in dollars per man-year were obtained by averaging similar type units.

(5) The OMA and MPA cost factors were expended as required for those units in oversea theaters. These cost factors were determined using the method shown in figure 3 and data from the COSTALS data bank for overseas operation.

b. Data Base for Major Budget-Category Factors. Application of the PEMA, OMA and MPA factors by type unit provided the data base for investment and annual operating costs for the CONAF non-COSTALS units as indicated in figure 4.

Item - Methodology	Example, Field Artillery Unit Unit Reference Sheet (URS) 6-31
1. PEMA, INITIAL	
A. Sum of Major Equip in PEMA [a]	$4,588,165
B. Other PEMA Factor	0.211
C. PEMA, Initial Total A (A x B)	$5,556,267
2. PEMA, ANNUAL	
D. Personnel Strength (URS)	611
E. Ammo Factor	$692/man
F. Ammo Consumption D x E	$422,812
C. PEMA, Initial Total	$5,556,267
G. PEMA, Annual Factor	0.071
H. PEMA, Annual Total (C x G) + F	$817,306
3. OMA, INITIAL	
I. OMA Initial Factor	$1,210/man
C. Personnel Strength (URS)	611
J. OMA, Initial Total I x D	$739,310
4. OMA, ANNUAL RECURRING	
K. OMA Annual Factor	$1,535/man
D. Personnel Strength (URS)	611
L. OMA Annual Total K x D	$937,885
5. MPA, INITIAL	
M. MPA Initial Factor	$2,568/man
D. Personnel Strength (URS)	611
N. MPA, Initial Total M x D	$1,569,048

See footnotes at end of figure.

Figure 2-4-- Application of cost factors developed by USACDC SA Group [b]
(continued on next page)

Item - Methodology	Example, Field Artillery Unit Unit Reference Sheet (URS) 6-31
6. MPA, ANNUAL RECURRING	
O. MPA Annual Factor	$5,647/man
D. Personnel Strength (URS)	611
P. MPA Annual Total O x D	$3,450,317
7. OMA INITIAL OVERSEAS	
J. OMA Initial Total	$739,310
Q. OMA Overseas Factor	1.3
R. OMA Initial Overseas Total J x Q	$961,103
8. OMA ANNUAL RECURRING OVERSEAS	
L. OMA Annual Total	$938,496
S. OMA Overseas Factor	1.49
T. OMA Annual Overseas Total L x S	$1,398,359
9. MPA INITIAL OVERSEAS	
N. MPA, Initial Total	$1,569,048
U. MPA Initial Factor	1.19
V. MPA Initial Overseas Total N x U	$1,867,167
10. MPA ANNUAL OVERSEAS	
P. MPA Annual Total	$3,450,317
W. MPA Annual Factor	1.11
X. MPA Annual Overseas Total P x W	$3,829,851

[a] List of major equipment in the URS was hand costed using costs data from DA Supply Bulletin SB 700-20.

[b] Derivation of Cost Factors shown in figure

Figure 2-4--Application of cost factors developed by USACDC SA Group [b] (concluded)

(2) The total initial investment cost was computed as follows and placed in the SA Group data bank. The major PEMA items indicated in individual non-COSTALS URS or SRC were hand-costed by multiplying the number of each equipment item by the item cost to obtain the organizational cost of major items. This cost was multiplied by the appropriate cost factor to determine the cost of "other" PEMA equipment. The sum of the two was the total PEMA investment cost by unit. The OMA and MPA investment costs were determined by multiplying the personnel strength of the appropriate cost factor. Oversea factors were applied by theater of operation. The sum of these cost entries then became the total investment cost for the organization.

(2) Total Annual Operating Costs. The total annual operating costs were computed as follows and placed in the data bank.

(a) The annual PEMA cost for non-comparable units was obtained by multiplying the total PEMA investment cost by the appropriate percentage factor (by type unit) and adding the annual ammunition/missiles consumption costs.

(b) The annual OMA and MPA costs were determined by multiplying the total personnel strength by the cost factor for each type unit. An oversea multiplier was applied by theater of operations.

(c) The summation of PEMA, OMA, and MPA costs by theater provided the total annual operating costs.

c. Application of Cost Factors. After the cost factors were developed, they were applied to the non-COSTALS units. The information was placed on cards. Master cards were prepared on all non-COSTALS units. The master cards were used to generate input cards to a computerized program that provided aggregated cost by unit and by force package.

18. COSTING OF TDA UNITS. Some units in the conceptual forces were organized under tables of distribution and allowances (TDA). These units are not comparable with SRC units contained in the COSTALS data bank. They were costed using per-man factors for PEMA, MPA, and OMA. The per man factors are based upon the COSTALS cost factors.

19. INCREMENTAL MATERIEL COSTS. Incremental costs are the differences in unit costs resulting from unit equipment changes that are listed in the Allocation of Equipment Modernization Items addendum prepared for each concept. The designer, in these addendums, allocated newly developed equipment to some units, adjusted the mixture of combat weapons in certain units, and in some instances, substituted equipment for equipment listed in G-series or prior TOE (e.g., Helicopter AH1G for Helicopter UH1B/C). To cost CONAF

forces fully, the cost results from the COSTALS program were adjusted to reflect these equipment changes. The cost elements affected and the method of computation for these cost elements are as follows:

a. PEMA Major Equipment. PEMA major equipment (PME) cost was determined by computing the cost of the new equipment, subtracting from it the cost of equipment to be replaced as reflected in the COSTALS program and then adjusting the original PME cost computed by the COSTALS program.

b. Other Initial PEMA. Other initial PEMA was computed by applying factors for operational readiness float (ORF), repair cycle float (RCF) and PEMA repair parts (7 percent of (PME + ORF + RCF)).

c. Annual PEMA and Operating Costs. Annual operating cost for PEMA major equipment, PEMA repair parts and OMA program 2 was adjusted by applying factors listed in the Army Force Planning Handbook, October 1971, to computed incremental costs and adjusting the COSTALS computed cost accordingly.

Section VI. METHODOLOGY FOR COSTING RESERVE COMPONENTS AND CIVILIAN SUPPORT

20. INTRODUCTION. The USACDC tasking directive specified that alternative type force designs would be costed in terms of all appropriation categories to include Reserve components. Although not specifically mentioned in the directive, civilian support was partially costed. An examination of this problem indicated that the number of civilians associated with the conceptual forces were quite significant. A description follows of the methodologies developed for the costing of Reserve components and civilian support.

21. COSTING RESERVE COMPONENTS. The purpose of the Reserve components is to provide trained units and qualified personnel available for active duty in the Armed Forces in time of war or national emergency.

a. Costing procedures. The Reserve components were costed using the procedures developed for costing similar Active Army units, but with factors applied as directed by COA as follows:

> "For comparative purposes in the costing like units in the Reserve Components and Active Army Reserve Component, personnel costs are 16% and OM costs are 25% of Active Army costs.
>
> "Active Army costs about 10% of PEMA investment as replacements. Since, as a rule Reserve Components have about 40% of combat serviceable equipment on hand, and FY 71-72 issues are in the main new or rebuilt and not likely for replacement in the next five to seven years, a 4% of investment costs appears more equitable for PEMA replacement."

b. Application of Cost Factors. The output data obtained using COSTALS to cost Reserve components does not represent true Reserve component costs. Therefore, these data were modified. Cost factors applicable to Reserve components (data from COA) were applied to the COSTALS output data to scale down the PEMA, MPA, and OMA costs, i.e., from Active Army to Reserve component units. The Active Army cost factors are described in volume III, chapter 5.

22. DEVELOPMENT AND COSTING OF CIVILIAN MANPOWER STRENGTHS:

a. Types of Civilian Personnel. Civilian personnel are employed to reduce the military support needed to maintain a large military force. Civilian employees are of three different types: Direct hire US civilians, direct hire indigenous personnel, and contract or indirect hire personnel who have been hired by commercial firms to provide services to the armed forces and are not subject to direct controls of the employing force.

b. Identification of Civilian Manpower Strengths:

(1) The numbers of civilian personnel were available by force and alternative design. A methodology has not been developed to determine whether the civilian personnel support provided for the conceptual forces is within the baseline strength or is in excess of the number of personnel that should be allocated to the Army in the field. However, manpower cost factors were applied to determine the cost for supporting these individuals identified by force package. As an example, the number of civilians in the baseline force and in concept II, alternative A - European Based Force, was obtained. On 30 June 1971, the total number of civilians and contract personnel (sometimes called "indirect hire") in the Baseline European Force actively supporting "the Army in the Field" was approximately 24,000; about 21,000 were indirect hire and about 3,000 were direct hire US citizens and/or foreign nationals. The total number of civilians and contract personnel in concept II, alternative A, is approximately 14,000. This figure is equally divided between contract personnel and civilians. In addition, 41 types of units with civilians were identified as having similar units in the baseline force. Of the 41, there are only 13 that presently have civilians or contract personnel employed. Additional units that are not included in the CONAF designs also employ civilians; these are included in the baseline working force.

(2) Sources of civilian strengths. The preferred source for development of the baseline civilian support personnel is ACSFOR Report 128, Manpower Subject to Department of the Army Manpower Voucher, since this is developed quarterly. This report includes the foreign and direct hire civilian allocation, the actual civilian strengths for US direct hire, direct hire non-US and

indirect hire. Another excellent source for manpower figures is Department of the Army Force Accounting System Active Army Troop List. The procedures for development of civilian strengths are in appendix F.

Section VII. EQUAL-COST FORCES METHODOLOGY

23. GUIDANCE PERTAINING TO EQUAL COST FORCES. The Department of the Army and the USACDC CONAF study directive did not provide any reference to equal-cost forces. In addition, none of the CONAF guidance received by the USACDC from the Department of the Army indicated that the concept of equal costs, as such, should be applied to the CONAF study. However, in view of the direction received from HQ, DA to develop a constrained costing methodology and to cost forces within budget constraints, it was considered reasonable and desirable to develop and apply an equal-cost methodology.

24. REMARKS RELATING TO EQUAL-COST FORCES. In October 1970, USACDC representatives met with the CONAF cost subcommittee. Certain revisions in the cost analysis methodology were agreed to at the meeting. The subcommittee suggested that evaluation and costing be devoted to a task of assuring that designs are equal cost or approximately equal cost. (So that the decision is not that "more is better than less."[8]) In April 1971, the cost subcommittee was given a briefing that included a discussion of equal-cost forces. The proposed definition of equal-cost forces was not approved, disapproved, or redefined; therefore, acceptance of the briefing was assumed.

25. INTERPRETATION OF EQUAL-COST FORCES:

a. Conceptual Forces. The conceptual forces being evaluated in the CONAF study were considered to be equal-cost for the purpose of this analysis if two criteria were met:

(1) Comparative costs were approximately equal for the forces evaluated in the combat effectiveness appraisal by the Combat Effectiveness Model (CEM).

(2) TOA (PEMA + MPA + OMA) for the total forces were approximately equal.

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[8] USACDCISA Memorandum for Chief of Staff CDISA-CO 30 Oct 70. ISA Plans to Support CONAF in Accordance with Sub-SAG Guidance.

b. Equal Comparative Costs. If the total 10-year systems costs for any design exceeded or was below the total estimated cost of the baseline force by an amount of 10 percent or more, a recommendation was made to the designer that this design or designs should be dropped or re-examined for the purpose of restructuring the design.

c. Equal constraints. The dollar and manpower constraints pertaining to personnel and equipment are described in detail in volume I, chapter These budgetary and manpower constraints were applied to the conceptual units making up the designs. If, through the application of these criteria, designs were satisfactory, no other action was taken. However, when costs and quantities of major items of equipment and personnel were found to exceed the established constraints, adjustments were made to the conceptual forces to bring them within the constraint ceilings. These adjustments were facilitated by the use of force matrices which are summarized below.

d. Force Matrices. A series of organizational/manpower matrices was developed to provide a base for evaluating conceptual forces vis-a-vis the baseline force. Each unit in the baseline force and each of the units in the conceptual forces was coded to identify its basic function, i.e., either combat or support. The units were processed through the Battalion Slice Model to convert all forces to a standard base. The results of the computer run were used to develop percentages and functional matrices. The functional percentages for any conceptual unit could then be compared with similar baseline percentages to determine distributions of personnel and materiel among combat functions in the conceptual designs and the baseline force. These differences were identified to the designer for verification and analysis. (*See volume VIII for detailed description.*)

26. FORCE COST METHODOLOGY COMPARISON:

a. Comparison of the Baseline Force with PEMA CONAF Guidance Constraint. The cost and quantities of major equipment items within the projected baseline force were aggregated to provide total dollar expenditures for the procurement period FY 1976-1980. This total was then compared with the PEMA guidance constraint. When the total procurement dollars exceeded the constraint, the designer was apprised and appropriate adjustments were made to reduce PEMA expenditures to fall within the constraint. The methodology used in making this determination is discussed in section VIII of this chapter.

b. Comparison of Conceptual Forces Costs with Baseline Force Costs. Initial and recurring OMA, MPA and PEMA costs were derived for the baseline and conceptual alternative designs. Ten-year system costs for the alternative designs were then compared with similar 10-year baseline force costs to ensure that the cost of conceptual forces is within the 10 percent bounds of the baseline force costs. This comparison is presented in volume VIII.

Section VIII. MATERIEL ANALYSIS METHODOLOGY

27. GENERAL:

a. Determination Of Materiel Requirements. The analysis of materiel was accomplished by summing materiel by line item for each alternative, adjusting for modernization as appropriate, adding prepositioning of materiel configured to unit sets (POMCUS)[9] and PEMA factors and other requirements to obtain total requirements. These requirements were compared with available assets to determine PEMA materiel necessary to equip each alternative. To allow the comparison of alternative resource requirements, charts have been prepared to show the materiel breakout (by acquisition cost and percentage of force-package totals) for the European Force of each force package. The requirements are identified by function and subfunction within procurement-appropriation activity. A review of the production capacity[10] was made to insure that the quantity required could be delivered in the time frame under consideration.

b. Calculation Of Dollar Costs. Dollars required for PEMA procurement for this period were calculated using costs approved by the Director, Cost Analysis, Office of the Comptroller of the Army, and guidance obtained from DA sources listed in appendix A, volume III. PEMA dollar constraints for FY 1976-1982 were as outlined in volume I, Constraints and Guidance. The portion of the PEMA appropriation available for CONAF-selected procurement was that portion remaining after fenced and other POM programed procurement - not specifically CONAF oriented - were funded. Materiel Procurement Priority Review Committee reports were used to supplant the POM for years after 1977. Figure 2-5 lists materiel items for other POM programed procurement.

c. Materiel Analysis Flow Chart. A materiel analysis flow chart (See figure 2-6) portrays the methodology used to arrive at the recommended PEMA program.

28. MATERIEL REQUIREMENTS:

a. Units. The list of units was obtained from the USACDC CONFOR GP. Units are listed by TOE or URS and the number of each type of unit for each force within each alternative. The URS is a conceptual TOE for a proposed CONAF unit; it lists the number of personnel and the quantities and types of major equipment.

b. Equipment Allocations. The designer published an "Allocation of Equipment Modernization Items" that contained equipment allocations for

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[9]Appendix G presents a short description of POMCUS.

[10]Major Item Distribution Plan, published quarterly by USAMC Commodity Commands.

Activity 1 and 2

AIRCRAFT

Heavy Lift Helicopter (HLH)

Utility Tactical Transport Aircraft System (UTTAS)

Utility Helicopter (UH1)

Light Observation Helicopter (LOH)

Unmanned Aerial Surveillance System

GSE (Avionics & Equipment)

Modification & Retrofit (Less AH1G)

Activities 3 and 4

MISSILES

SAM-D

Improved HAWK (Missiles)

Redeye II (Manpads)

AN/TPX 46

AN/TSQ 73

AN/TPM 25

DRAGON (Missiles)

Shillelagh

TOW (Missiles)

Activities 3 and 4 (Cont)

MISSILES (Cont)

Honest John

Modification of in-service equipment

Misc (*PBS, FDT, Item less than $M)

Air Defense Targets

LOFAADS

LANCE (Missiles)

Missile Repair Parts & Support

Activity 5

COMBAT VEHICLES & CREW SERVED WEAPONS

Armored Reconnaissance Scout Vehicles

Mechanized Infantry Combat Vehicle

Bushmaster

Reconnaissance Vehicle M88 (Modified)

Howitzer, 155MM, towed (XM198)

Howitzer, 105MM, towed (XM204)

Howitzer, 105MM, Self Propelled (XM)

Reconnaissance Vehicle (XM 742)

Armored Vehicle Launch Bridge

Machineguns

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*PBS - Production Base Support FDT - First Destination Transportation

Figure 2-5-- Other POM programmed materiel items (continued on next page)

Activity 5 (Cont)

COMBAT VEHICLES & CREW SERVED WEAPONS

Lightweight Infantry Mortar

Battalion Close Support Weapons Systems

Activity 6

TACTICAL VEHICLES

Truck, 8 T 4 x 4, Goer

Truck, Utility ¼ T ABT

Truck, Platform, ½ T, M274

Truck, 3/4 T, M561

Truck, 2½ T, 6 x 6, ABT

Truck, 5 T, 6 x 6, ABT

Truck, Tractor, 10 T, M123A1C

Truck, Tractor, 22½ T, XM746

Activity 7

COMMUNICATION AND ELECTRONICS

STARCOM

AACOMS & Related Equipment

TRITAC

Five Year ADPE

TACSATCOM

Team Pack ESM

Multichannel VHF/UHF

Activity 7 (Cont)

COMMUNICATION AND ELECTRONICS (Cont)

Other Nontactical ADPE

Radios

Miscellaneous

Activity 8

OTHER SUPPORT

Combat Support (including bridges)

Construction Support (less FAMEC)

Landing Craft

Generators

Trailer

Tractors

Trucks, fork lift

Family of Engineer Construction Equipment

Modifications

Miscellaneous

Activity 9

AMMUNITION

Conventional

Other

Activity 10

PRODUCTION BASE SUPPORT

Figure 2-5-- Other POM programmed materiel items (concluded)

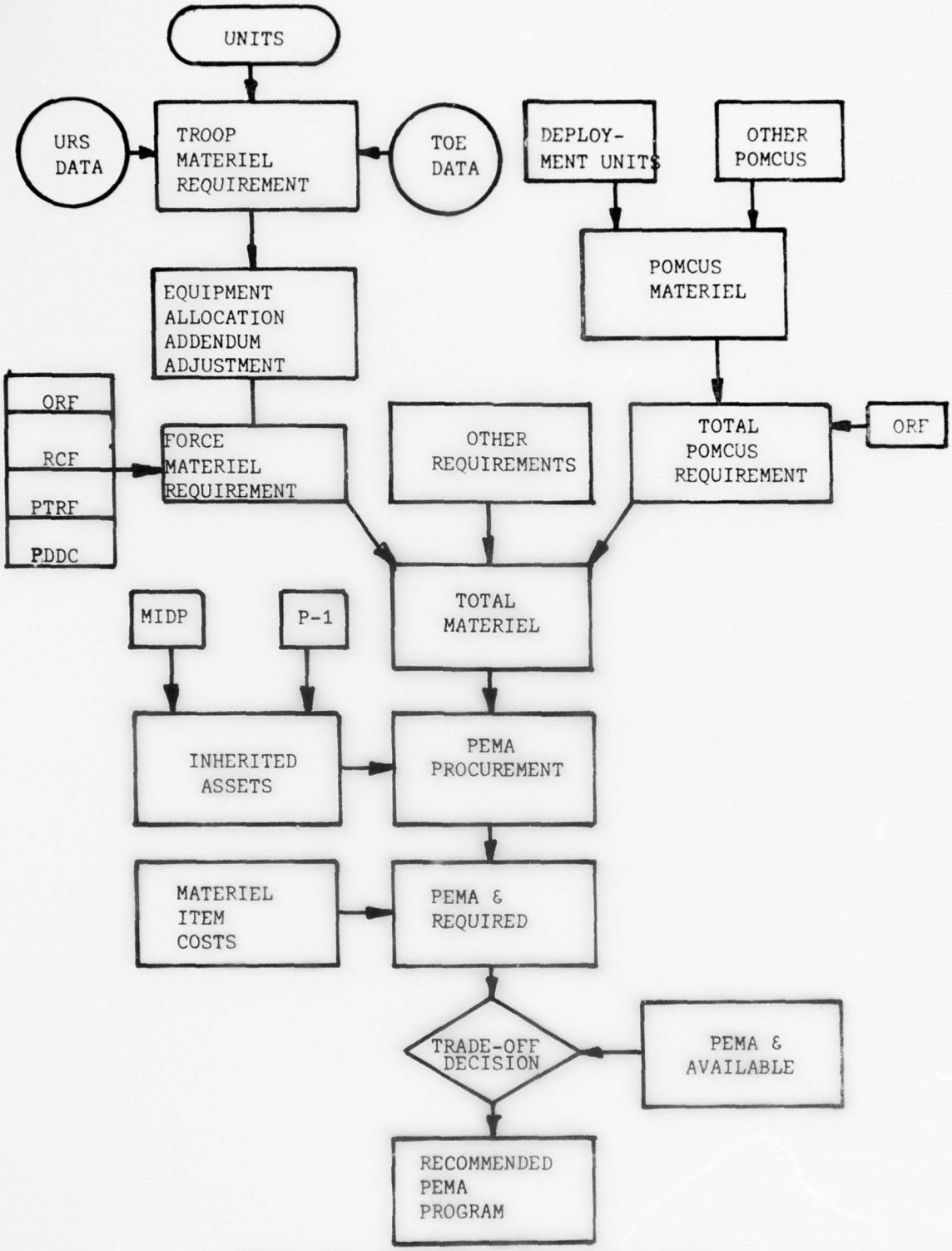


Figure 2-6--Materiel analysis flow chart

each force within each alternative in each concept. Major items allocated included those in development or under study with sufficient potential to warrant inclusion in procurement schedules.

c. URS and SRC Computer Programs. Two computer programs (one for URS and one for SRC) were developed to obtain equipment requirements by line item and dollar costs for each alternative. A description of the programs and executive flow charts is provided in appendix F.

d. Prepositioning of Materiel Configured to Unit Sets (POMCUS). European combat units for which POMCUS was required were designated by the designer. In addition, each alternative includes the lines of communications (LOC)/Port package (143 units), PAC land-based equipment and PAC floating base equipment. Requirements were computed using computer programs described in appendix F.

e. Elements of Materiel Requirements. Materiel requirements for a selected force are made up of the initial issue (II), which is the actual troop requirement and a proportion of the II which is determined by the sum of the following PEMA factors: (These factors, obtained from US Army Major Item Data Agency Report B057, are defined in appendix A, volume III.)

(1) Operational Readiness Float Factor (ORF).

(2) Repair-Cycle Float Factor (RCF).

(3) Peacetime Replacement Factor (PTRF).

(4) Post D-Day consumption Factor (PDDC).

f. Other Requirements. Other requirements include Training and remainder General Support Forces and Special Mission Forces requirements for new items not in inventory by the end of FY 1974. Data were obtained from the Major Item Distribution Plan (MIDP).

29. ASSET AVAILABILITY. Asset availability was determined by calculating inherited assets (end FY 1974) and then adding the equipment procured within budget constraints in budget years FY 1974 through FY 1980. It was assumed that delivery of equipment would occur in the year following planned procurement (i.e., materiel procured in FY 1980 would be delivered by the end of FY 1981.

a. Inherited assets. Inherited assets were obtained from the MIDP published by USAMC Commodity Commands responsible for the materiel items. In those cases where the MIDP did not reflect FY 1973 procurement, the FY 1973 procurement program was obtained from Exhibit P-1, DA Supporting Data for FY 73 Budget Estimate, Procurement of Equipment and Missiles, Army, 27 September 1971, prepared by Deputy Chief of Staff for Logistics, PEMA

Development Division. For this study, assets listed for Europe, Strategic Forces CONUS, Pacific, Korea and in depots were used.

b. Other Requirements. For materiel items not in inventory by end FY 1974, asset availability for CONAF design alternatives was reduced by other requirements as defined in paragraph 2f.

30. MAJOR ITEM PROCUREMENT PLAN. On completion of trade-off actions, the annual procurement plan for major items was determined using guidance for procurement phase-in provided by Weapons Systems Analysis Directorate, Office of the Assistant Vice Chief of Staff. Procurement phase-in is constrained by the PEMA appropriation available on an annual basis and feasible high and low annual production capability of the production base. To the extent PEMA funds are expected to be available, the procurement program was planned to coincide with the Army program objectives memorandum (POM) 73-77 and thereafter, to agree with the Materiel Procurement Priorities Review Committee (MPPRC) Report. In those cases where programed PEMA dollars were insufficient to procure all of the materiel planned for procurement for a specific fiscal year, programs were slipped in accordance with priorities established by the designer for implementation of preferred designs.

Section IX. TRADE-OFF METHODOLOGY

31. GENERAL:

a. Substitution of Production Factors. Given the substitutability of the production factors (labor-manpower and capital-materiel) germane to the design of military units and the characteristics of such organizations (e.g., cost, firepower, mobility, and intelligence-gathering and command-control-communications capabilities), it is easily seen that the set of possible trade offs in force design is rather large. In addition, the fact that a desired amount of D-day ground combat power may exist prior to M-day in several different states of organization and readiness compounds the problem. However, as inexact and suboptimal as the process may be, the current CONAF study has examined several alternatives which in effect do trade off among appropriation categories (with concomitant time-phased effects on capital requirements), materiel procurement schedules, or total force packages and/or their elements.

b. Optimum Force Design Trade-off Methodology. No optimum force design trade-off methodology has been developed to date; accomplishment of this objective must be positioned until the development of an acceptable array of measures of effectiveness (MOE) for military organizations.

32. LIMITATIONS:

a. Trade-off Limitations. This study makes appropriate trade offs in order to adjust the resource requirements of the various force designs to

conform to the guidance outlined in section IV, chapter 3,of volume I. At the same time, the "destruction of the enemy" (i.e., firepower) capability inherent in the designs was emphasized.

b. Measures of Effectiveness (MOE). Comphrehensive MOE are not available for combat intelligence-gathering capabilities, command-control-communications capabilities, or the combat service-support subfunctions. Consequently, CONAF trade offs were carefully calculated, insofar as possible, to minimize the adverse effects on these rather loosely defined areas. The overall effectiveness and efficiency of force design methodology will increase as areas other then "destruction of the enemy" (firepower) are developed defined, established, and weighed in the trade offs.

33. CONAF TRADE OFFS. Within the limitations--staying within resource constraints, preserving combat capability, and minimizing impact on support functions--the following types of trade offs were considered during the course of the study.

a. Force Package vs. Force Package. When a total force design exceeded constraints, the first trade off considered was a force package substitution. In the case of the designs described in volumes IV and V, an exchange was made for a smaller Strategic Reserve (in CONUS). The result was a decreased requirement for manpower and some reduction in materiel requirements.

b. Organization vs. Materiel. A second type of trade off attempted was substitution of less capital intensive organization (i.e., one with relatively less equipment or less expensive equipment) for selected organizations in the over-constraint design. For example, an Army Strategic and Tactical Reorganization Objectives (ASTRO) Infantry Division was substituted for an ASTRO Mechanized Division. In theory, the number of men and organizations can be reduced in order to supply better materiel to those remaining in the force.

c. Materiel Item vs. Materiel Item. The third type of trade off was substitution of less expensive (i.e., one with a lower procurement cost) materiel. Such trade offs led to reduced requirements in the force designs for the AH56A Helicopter and the XM803 Tank. (This trade off was later made mandatory by OSD and HQ, DA decisions on these systems.)

d. Materiel vs. Time. After determining that a particular design was within total constraints, it was examined to insure that annual resource availability limits were not exceeded. The guidance received regarding annual rates of expenditure, changes in appropriation levels, and production rates was expended through review of the Army Materiel Plan (AMP) and discussions with personnel of the Weapon Systems Analysis Directorate in the Office of the Assistant Vice Chief of Staff. The information obtained was used to develop time-phased materiel procurement projections. Based on PEMA

dollar constraints, these projections indicate the probable fiscal-year availability of planned new materiel.

e. Distribution of Materiel vs. Total Requirement. In the time-phasing of materiel procurement projections, distribution priorities were considered. It was assumed that procurement could not completely reach authorized acquisition objectives (AAO) prior to the end of the CONAF period. Instead, materiel in the following order:

(1) Initial issue and training base.

(2) Readiness floats.

(3) Prepositioned materiel.

(4) Reserve components.

(5) Post D-day consumption.

f. Active Army vs. Reserve Components. The design of each force concept was generated under resource constraints imposed in the CONAF guidance. In order to maximize the combat power of these constrained forces, Reserve component units were added as appropriate and consistent with their training, provisioning and deployment limitations.

g. Other Trade-off Considerations:

(1) Where appropriate, materiel was added to prepositioned sets.

(2) Force designs were updated to include new materiel items scheduled to be fielded prior to the end of the CONAF period.

(3) The added new-materiel systems, in turn, required some adjustments in the support structures of the forces involved.

(4) In summary, the adjustments described above carried several force designs over one or more of the resource constraints, most often in the areas of manpower and PEMA dollar limitations. These were again adjusted until designs were within all constraints.

34. TRADE-OFF CONSIDERATIONS IN THE FUTURE. As pointed out in paragraphs 31 and 32 the range of possible trade offs in designing military forces is quite large. Additionally, although the mechanical techniques involved in developing optimum solutions to such problems would probably yield to existing mathematical programing techniques, the input variables, in terms of performance parameters (or MOE) other than firepower, are still in such

a primitive stage of evolution as to be only marginally useful. These problems are under investigation by many concerned elements of the defense community. Assuming that suitable MOE will be developed, the availability of high-speed digital computers will, in the future, enable force designers to examine all aspects of the objective force, perform suitable sensitivity analyses, and develop improved force concepts.

Section X. TRANSITION SCHEDULE METHODOLOGY

35. GENERAL. Conceptual force designers must consider the straightforward melding of materiel, personnel (military-active and reserve-and civilian) training, and deployment requirements, but also they must be aware of possible synergistic effects due to the interdependence of these factors. Since evaluations such as these are more art than science, there is a risk factor involved that varies with the magnitude of the changes contemplated and the distance into the future over which changes are projected. For example, assuming that we want to realize the most efficient execution of plans, we are obliged to establish schedules or priorities for the activities involved--activities such as personnel procurement and training, materiel procurement and distribution and unit deployment. If the changes are relatively minor and if they are to be accomplished in the near term, the impacts of the changes and the associated risks will probably be minor. On the other hand, if changes are significantly drastic and if the period over which they are to be put into effect is relatively long, it is quite likely that there will be fairly high risks associated with possible force imbalances during some of the years of the objective period.

36. CONAF TRANSITION PLANNING. In view of the above and in order to recognize and evaluate the risks involved, this study includes a transition plan for the preferred designs of each concept. These plans identify the interim year-end force structures and appraise the risks involved.

a. Effect of State-of-the-Art. The state-of-the-art (and of the economy) being what it is, neither the transition plans nor the appraisals were meticulously calculated. Instead, projected distributions of materiel and personnel were examined and appraised against a constant threat. This process may have overstated the threat during the early transition years, but it did serve to indicate those years in which significant risks may be expected.

b. Materiel Distributions and Tentative Personnel Deployments. Materiel distributions and tentative personnel deployments were calculated and the resulting mixes as of the end of each year were subjectively appraised. These were based on the judgment of experienced military personnel. Then, to the extent possible, materiel procurement plans were adjusted to maintain a high level of combat capability.

c. Materiel Procurement and Delivery Effects on Transition Planning. A major effort in the transition plan was to assess the impacts of materiel procurement plans and plans for unit activations and inactivations within personnel-strength limitations for each of the preferred designs during the period from 1974 through 1982.

d. Development of Planning Data for the HQ, DA Staff. The transition planning was also developed to include the essential data for use by the HQ, DA Staff in translating a design to the POM format. These data include recommended force ratios, appropriation identification, resource schedules, and inventory objectives.

Section XI. CONAF COST METHODOLOGY LIMITATIONS

37. INTRODUCTION. Most of the problems remaining in the cost methodology can be traced to three causes. First, there are difficulties in defining sharp lines of demarcation, such as that between civilian elements supporting divisional forces (Army in the field) and general support forces. Second, the rapid pace of change necessitates the additional automation mentioned in section II. Third, as organization of the Army in the field changes with the elimination of echelons and with a reduction of division size, there are probably changes in OMA relationships. The direction and magnitude of these changes have not been identified.

38. CIVILIAN STRENGTHS. All of the conceptual force designs show significantly less civilian personnel than the baseline force. Consequently, the reductions in conceptual forces for civilian support appears to be a high-risk venture, unless sufficient logistic support can be provided.

39. CIVILIAN COSTS. In many cases civilian cost figures are questionable because it was difficult to determine their correct status, e.g., US civil service or foreign nationals. This civilian status could have a significant effect on total force costs in those instances in which large numbers of civilians were assumed to be part of the overall force.

40. FENCED PROGRAMS. The fenced programs, which are a part of the HQ, DA guidance, provided a restriction as to the amount of PEMA funds that could be provided for other CONAF items. However, some of the areas identified as "fenced" possibly should be examined as candidates for trade offs under increasingly tighter constraints.

41. COST FACTOR LIMITATIONS:

a. Materiel Prices. The use of SM 700-20 as the source of cost data for major equipment items can be erroneous, especially for those items which have been in the inventory for a number of years. The cost listed in SB 700-20 for any particular item is the last price paid for that item. Thus, the price that would have to be paid to purchase that item now or in the future could be significantly greater than the quoted price in the SB 700-20.

b. Effects of Pay Increases. The latest military pay raises have not been incorporated into the cost calculations for the various concepts. Pay raises could have a significant effect on the number of personnel that can be acquired for X number of dollars and hence on the feasibility of any particular alternative. This statement is particularly true in view of the magnitude of the latest raise that was made with the concept of an all volunteer Army in mind.

42. OMA COSTS. The relationships of OMA costs in weapons system costing under AR 11-18 could change under changing concepts for Army in the field organization and logistics. These relationships need to be measured in order to facilitate force costing of modernized units. The effect on total costs of substituting new materiel must be ascertained more accurately.

43. OTHER LIMITATIONS:

a. Undefined Major Items of Equipment. Unit reference sheets and organizational units not identified with a SRC or TOE often did not specify all appropriate major items of equipment. For these organizational units, the major items of equipment were estimated from similar type units.

b. Concepts Using Materiel Dropped by Congressional Action. Any concept(s) which included the XM803 (MBT-70) as part of its equipment should be recosted in view of the recent Congressional decision to stop the program. Perhaps other development programs are in a similar situation. (The cutoff for this current study was 15 January 1972. Consequently, several of the designs included in volume VII retain the XM803 costs.)

CHAPTER 3

CONAF THEATER FORCE EVALUATION SYSTEM

Section I. INTRODUCTION

1. PURPOSE. This chapter contains the background and general description of the Theater Force Evaluation System for CONAF, developed by the Research Analysis Corporation (RAC), McLean, Virginia.

2. BACKGROUND. RAC learned that it possibly would participate in the Conceptual Design for the Army in the Field (CONAF) study on 27 November 1970 when members of the CONAF Evaluation Assistance Group (CEAG) visited RAC and informally discussed the project and its status. During the following 2 months, RAC rearranged its ongoing Work Year (WY) 1971 and prepared a research plan for its participation in the CONAF project. Formal, contractual work on the project began 1 February 1971 with an interim completion date of 31 August 1971. Appendix I contains a detailed background statement of RAC's participation in the CONAF study.

3. RAC OBJECTIVES. RAC's objectives were twofold:

a. To produce a model that would permit the rapid simulation of large-scale warfare and to use that model to analyze certain CONAF-developed alternative force designs. (The RAC-developed theater combat model (TCM) was considered the best available base from which to develop a model suitable for CONAF purposes. However, it was untried and it required modifications before it could be used with the wide variety of combat units conceived for analysis.)

b. To transform the TCM into a CONAF evaluation model (CEM).

4. SCOPE AND ASSUMPTIONS:

a. A RAC WY is from 1 September through 31 August. RAC's efforts on CONAF during the 7 available months of FY 1971 (Feb through Aug) would have to be of more limited scope than the ultimate needs that the project required. The most urgent need was to develop an operational model suitable for the analysis of the markedly different conceptual forces that were to be evaluated. This task alone could have consumed all available manpower. However, the Army, wanted RAC to actually analyze the combat capabilities of a number of the initial CONAF-developed alternative force designs for the European theater. Army designers needed the results of such analyses to assist them in selecting preferred designs. Given the the available means, this task too could have used all available manpower.

b. Therefore, expecting that CONAF would be a continuing project, RAC, with the concurrence of the Army, limited the scope of its FY 1971 effort. The major initial effort was devoted to transforming the existent

TCM into a useful CEM. However, time constraints were severe so the scope of the effort was limited to essential changes plus "nice to have" changes only to the extent time allowed. The Army understood and agreed that many desirable improvements could not presently be made, but would be identified for accomplishment in the future.

c. As soon as RAC developed a useful CEM it was to be applied to the analysis of at least two, and possibly three, conceptual forces. Each concept comprised a baseline force and several alternatives: six for concept I and five for concept II. Concept III involved nuclear warfare and, since the TCM had been designed to simulate nonnuclear warfare, the designers doubted that the CEM would be appropriate for the analysis of concept III forces.

d. Recognizing the scope of the problem and anticipating probable limitations of the initial CEM, RAC included in its scope of effort, plans to analyze the capabilities of the various force designs independently of the CEM. These were called auxiliary analyses and were considered essential.

Section II. SYSTEM METHODOLOGY

5. GENERAL:

a. In its current form, the RAC-devised Theater Force Evaluation System for CONAF has two means for evaluating the military capabilities of a theater force. (See fig 1.) The principal means is a computerized model designed to simulate the advance and retreat of brigade and larger size units engaged in combat at the forward edge of the battle area (FEBA). It is called the CONAF CEM and is identified as a warfare simulation to distinguish it from war games, which generally involve human participants. In the CEM, the outcome is deterministic. That is, if the input conditions do not change, a second run of the model will produce exactly the same results as the first run. On the other hand, the second play of the same initial conditions in a war game may, because decisions by human players are involved, produce quite a different outcome. For the purpose of comparing CONAF alternative force designs, a deterministic simulation is preferred to a nondeterministic war game.

b. Theater force capabilities also are evaluated by means of auxiliary analyses. An auxiliary analysis, in this context, is an essentially subjective examination of the men, equipment, and procedures available to perform selected important military functions that either are not at all accounted for in the CEM or are less than adequately simulated.

6. CONAF EVALUATION MODEL--GENERAL DESCRIPTION:

a. The CEM simulates two-sided, Red and Blue, conventional war in which the area of direct combat activity can be defined by a line called the

OVERVIEW OF SYSTEM

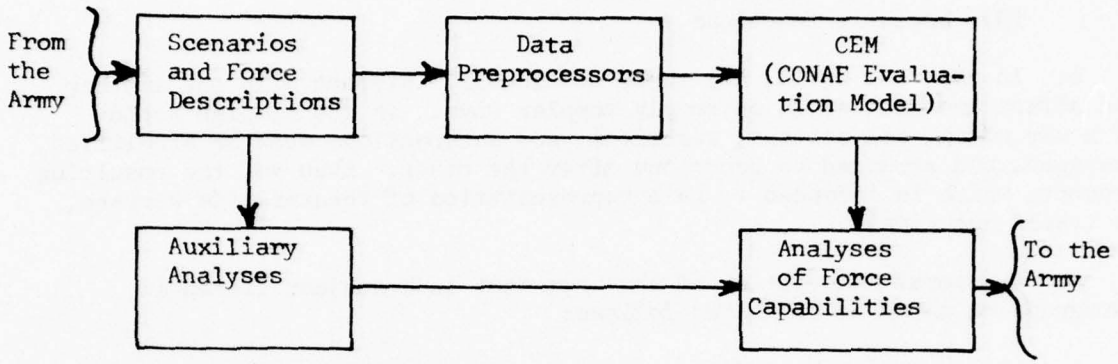


Figure 3-1 -- CONAF force evaluation system

NOTE: The Army provides RAC with scenarios and detailed descriptions of the forces for various postulated future combat situations involving at least several divisions. Through "data preprocessors" information from the Army is converted as necessary to make it suitable for input to the CEM. The CEM is a completely automated set of computer programs that simulates the major combat activities of a theater force over an extended time. Output from the CEM is combined with results from auxiliary analyses to produce an analysis of the combat acapabilities of the force being considered. Such analyses are transmitted to the Army for comparison and further evaluation with the objective of identifying preferred force designs.

FEBA. Time compression in the CEM is on the order of 3,000 or 4,000 to 1. Twenty-four hours of war is simulated in less than 30 seconds. All calculations are done by a digital computer (a control data corporation model 6400) and everything simulated must be represented by numbers. The CEM simulates:

(1) Ground combat units.

(2) Artillery units.

(3) Attack helicopters.

(4) Tactical aircraft operations.

(5) Combat engagements.

(6) Terrain and its effects.

(7) Combat capability.

(8) Logistic functions.

b. In the real world, all these continually interact with one another and affect one another in extremely complex ways. In the simpler world of a war model, all actions, reactions, and interactions must be simplified, averaged, and arranged to occur one after the other. Even so, the resulting product, which is intended to be a representation of theater-wide warfare, is itself not simple.

c. A general description of the ways that each subject listed in paragraph 6a above is simulated follows:

(1) Ground Combat Units:

(a) As the size of the smallest unit simulated decreases, the number of units to be accounted for increases with a consequent increase in the complexity of the model and an increase in the time required for a run. On the other hand, as the size of the smallest unit increases, the amount of information available from a run decreases. Brigades, which could be described in terms of their component battalions, were considered to be the optimal choice for the Blue Force. The corresponding echelon for Red would be regimental. However, because a Red regiment is typically smaller than a Blue brigade and there was less interest in a detailed analysis of the Red Force, divisions were selected as the smallest Red units to be simulated.

(b) A Blue division in the CEM always comprises exactly three brigades. Larger organizations on each side are simularly represented. Two to five divisions make a corps, two or five corps make an army, and one or more armies constitute the theater force. (The simulation of artillery units is discussed below.)

(c) Nondivisional units cannot be discretely simulated. Screening and reconnaissance elements and other independent units must be incorporated into brigades and made part of a division. Another present limitation is that the extra freedom of movement inherent in special units such as an airmobile division cannot be adequately simulated.

(2) Artillery Units:

(a) Up to eight different types of field artillery battalions can be simulated in the CEM in terms of their firepower. All

eight types of artillery battalions may be assigned as general support. A given division may have any militarily reasonable number of battalions of only one type of general support artillery, but the type may vary from division to division. An army may have any or all eight types assigned for general support. During a run of the CEM, army artillery is allocated to corps, which subsequently allocate it to division. All artillery units of on-line divisions are considered active all the time and they do not suffer attrition. However, only the fires of those assigned a direct support role are considered in determining the outcome of brigade engagements.

(b) Artillery battalions may be assigned to direct support in either of two ways: by definition in the input to the CEM or by reassignment from general support to reinforcing direct support as called for by the battle situations arising during a run. In the present model, every Blue division has three direct support artillery battalions (one per brigade) assigned as an input. The number initially assigned to a Red division may vary from zero to any militarily reasonable number.

(c) A fraction of the firepower of each general support artillery battalion assigned to a Blue division may be allocated to each of its brigades as reinforcing direct support. Since Red divisions are not organizationally subdivided in the CEM, all their general support artillery can be assigned to the reinforcing direct support role.

(d) The availability of artillery ammunition is not a limiting factor in the CEM. Rather, the CEM is used to generate requirements by assuming that appropriate ammunition is available as required. What is required is determined by the nature and duration of the battles being supported.

(e) If it would make a significant difference in the estimated outcome of an engagement (e.g., change a draw to a win), the rate of fire* of supporting artillery units may be increased during that engagement.

(3) Attack Helicopters: Attack helicopters are simulated as integral components of individual Blue brigades. They are identified by a separate entry in the brigade firepower matrix (explained later). When the CEM was constructed, presumably the Red Force would not include a significant number of attack helicopters and, therefore, no provision was made for simulating them on the Red side.

(4) Tactical Aircraft Operations:

(a) The CEM represents tactical aircraft by three notional types: air defense fighters (ADF), tactical fighters (TF), and sweep

*The CEM does not actually consider individual weapon or battery rates of fire. Instead, it measures artillery usage in terms of ammunition expenditure rates during 12-hour periods (each division cycle).

fighters (SF). These aircraft may be assigned to various kinds of missions, such as to engage and destroy enemy aircraft in the air, to destroy parked aircraft and enemy surface installations, and to provide close air support (CAS) to friendly troops.

(b) During a run of the CEM, the number and the proportion of available aircraft assigned to the various missions change in accordance with loss rates and the needs of the ground combat units. Aircraft assigned to a CAS mission are treated as additional fire support and are thereby influential in determining the outcomes of ground combat engagements.

(5) Combat Engagements:

(a) Ground combat units can have one of three missions: to attack, to defend, or to delay. At the Blue brigade--Red division level, a mission is determined once every 12 hours. Twelve hours, called a division cycle or period, is the minimum time recognized in the CEM. It was selected partly on the premise that a division normally would not change missions more than once in 12 hours and partly in the hope of avoiding a need to distinguish day from night. (The 12 hours is assumed to be defined by mid-darkness and mid-daylight.) Higher echelon cycles are 24 hours for corps, 48 hours for army, and 96 hours for theater. To select a mission, the model simulates the making of an "estimate of the situation."

(b) When a unit's mission is to defend, it will be in either a prepared or a hasty position. The significant difference is that a unit defending a prepared position is harder to defeat than a unit defending a hasty position. If the FEBA has been moving at a rate exceeding some specified rate, a hasty position defense will be presumed. Otherwise, presumably the unit has been able to create a prepared position. The critical rate is an input that can be changed, and the same rate applies to each unit on a side.

(c) Figure 3-2 displays the kinds of engagement that can result from each side's choice of a mission. If both sides opt to attack, a meeting engagement occurs. If both sides choose to defend or delay, their segment of the FEBA is considered quiet for the ensuing cycle. Other possible situations are an attack against a prepared or hasty position or an attack against a delaying force.

(6) Terrain and its Effects:

(a) Terrain, as simulated in the CEM, affects troop movement rates and influences the utility of weapons. Presumably, as terrain changes from flat and open to irregular and heavily vegetated, vehicles have increased difficulty moving and the average line-of-sight (LOS) distance decreases. The first effect gives raise to the use of different movement rates and the second effect provides a basis for altering the effectiveness of weapons in accordance with the terrain where they are being used.

			RED MISSION		
			DEFEND		
BLUE MISSION		ATTACK	PREPARED POSITION	HASTY POSITION	DELAY
Attack		Meeting engagement	Blue attack of prepared position	Blue attack of hasty position	Blue advance
Defend	Prepared position	Red attack of prepared position	Quiet	Quiet	Quiet
	Hasty position	Red attack of hasty position	Quiet	Quiet	Quiet
Delay		Red advance	Quiet	Quiet	Quiet

Figure 3-2 -- Engagement simulated in the CEM

(b) The CEM recognizes three types of terrain: A, B, and C. For movement rate adjustment, they are distinguished by their trafficability. Type A offers negligible impedance to vehicular movement either on or off roads. Type B makes cross-country vehicular movement possible, but difficult. Type C confines vehicular to existing roadways.

(c) For weapon effectiveness purposes, the terrain characteristic of principal interest is the average LOS distance. In general the average LOS distance was assumed to be longest in type A terrain, shorter in type B, and shortest in type C. If a weapon is most useful where the average LOS distance is about the same as the weapon's effective range, then the weapons' effectiveness meausres can be modified in accordance with the existing terrain. To illustrate this point with extreme cases, consider: (1) a rifleman in type A terrain where he can see for thousands of meters and (2) a tank gunner in type C terrain where the average LOS distance is a few hundred meters or less. The rifleman will be able to acquire targets that he cannot hit and the tank gunner will not be able to see targets that, given a clear LOS, he could hit. Neither weapon could be used to its maximum effectiveness.

(d) A fourth terrain class, type D, represents unusual man-made or natural barriers, such as extensive minefields; wide, unfordable rivers; or long escarpments.

(7) Combat Capability:

(a) Fundamentally, the combat capability of a unit in the CEM is measured in terms of firepower, but the basic firepower potential of a unit undergoes several modifications to reflect the assumed circumstances of each engagement being assessed. Firepower, in this context, is a measure of the average casualty-causing capability of a weapon with respect to other weapons rate on the same or a compatible basis. Each weapon has its own firepower potential; and the firepower of a unit, such as a battalion, is the sum of the firepowers of the weapons in the unit. Every combat and combat support unit simulated in the CEM is described in terms of its firepower.

(b) In the CEM, each weapon is classified according to the nature of the targets it normally would fire at and according to the kind of source the weapon is itself. Targets are classified as tanks, light-armor, or personnel. As sources of firepower, those target classes are called hard, medium, and soft respectively. A tank, with its main gun and machineguns, is a hard source of antitank, antilight-armor, and anti-personnel firepower. A rifleman is a soft source of antipersonnel firepower. The firepower of a Blue brigade's ground combat units can be displayed in a simple matrix such as figure 3-3.

TARGET CLASS	SOURCE CLASS HARD	MEDIUM	SOFT
Tanks	20	30	10
Light armor	10	15	15
Personnel	5	10	20

Figure 3-3 -- Hypothetical Blue brigade firepower matrix (-)

(c) When the firepower of opposing Red Forces is similarly arrayed the force ration can be determined on a basis that considers the relative magnitude of each class of firepower on one side weighted by the proportion of suitable targets available on the other side. For example, the Blue brigade in figure 3-3 above has a total antitank firepower of 60 (sum of top row) and 75 units of antilight-armor and antipersonnel firepower.

(d) If the opposing Red Force had no tanks, Blue's 60 units of antitank firepower would not be counted. The extreme is that if the Red Force had only tanks, Blue's 75 units of antilight-armor and antipersonnel firepower would be ignored.

(e) CEM's ability to dynamically adjust firepower scores in accordance with changing situations during a run is an important feature of the model. It contributes much toward discriminating one force from another.

(f) An actual firepower matrix would contain two or three more columns than figure 3-3 shows. Both Red and Blue can have firepower from artillery and from CAS aircraft. In addition, Blue (but not Red) can have attack helicopters as a firepower source. These additional sources of firepower are not considered as targets for the ground maneuver units represented by the weapons in the hard, medium, and soft source columns.

(g) Combat losses to artillery units are not simulated in the CEM, but artillery firepower is modified by an artillery coordination factor. This factor is a means for reflecting the belief of an effectiveness relationship between the number of supporting artillery units and the number of combat units being supported.

(h) The availability of CAS aircraft and their losses are handled by the tactical aircraft operations cycle almost independently of the ground combat cycles.

(i) Although attack helicopters are considered integral components of Blue brigades, the loss of helicopters is not specifically simulated. However, their firepower can be reduced as if they were being lost. For any given engagement, Blue, on the basis of input parameters, will have an "acceptable" helicopter loss rate. Red, on the basis of input parameters and the circumstances of the engagement being assessed, will be able to cause a determinable loss rate on Blue helicopters. The ratio of these two rates is used to modify Blue's helicopter firepower. If Blue's acceptable rate is higher than Red's capability to inflict losses, helicopter firepower is unchanged. If the rate is lower, helicopter firepower is reduced by multiplying the unreduced value by Blue's acceptable loss rate divided by Red's capability rate.

(j) The general capability of a maneuver unit to undertake combat missions is measured in terms of its "unit state" on a scale from 100 down to zero. A fresh, full strength unit has a unit state of 100. After its first division cycle in combat, the unit loses a number of unit state points reflecting the nature of the engagement and its outcome. Its unit state may also be increased if replacement personnel and additional materiel are received. So long as the unit is in battle, this loss and recovery of unit state points occur during every division cycle. Additionally, to account for men and weapons temporarily out of action and the general effects of fatigue and tension from being in combat, a fixed (by input) number of state points are deducted from a unit's state at the end of its first division period on the line. These points are not regained until the end of the first cycle after the unit has been withdrawn to reserve and presumably has had time to rest and perform some maintenance. They cannot be regained during battle by the receipt of replacements or resupply.

(k) The unit state value determines the kind of combat activity (attack, defend, or delay) that a unit is permitted to undertake. For example, attack and defend thresholds may be set at 75 and 50 respectively. Under these conditions, a unit with a state at or above 75 may attack, defend, or delay; a unit with a state below 75, but at or above 50, may defend or delay; and a unit with a state below 50 may only assume a delaying mission. The actual selection of a mission within these constraints, however, is based on an estimate of the situation.

(l) Unit state also is used to modify firepower. After a unit's firepower is a given engagement has been determined with all other factors (terrain, posture, etc.) considered, it is multipled by its current unit state divided by 100. In other words, a unit at state 67 is credited with only 67 percent of the firepower it would have if its state were 100.

(8) Logistics Functions:

(a) The CEM treats logistic functions in an aggregated manner. All movement of replacement personnel and resupply of materiel is embodied

in a conceptual "resource unit." A resource unit is a combination of men and tons of materiel in a ratio equal to the receiving unit's average needs over a long period (months) of active duty in combat. Different maneuver units have different average long-terms needs.

(b) A unit's loss of state points resulting from combat is regarded as a consumption of resource units. The number consumed depends on the nature of the engagement and its outcome. To recover lost state points, a unit must receive and assimilate additional resource units.

(c) An input to the CEM is a schedule of the arrival of resource units in the theater. In accordance with rules based on a "to each according to his needs" philosophy, resource units are allocated from theater to armies, armies to corps, corps to divisions, and (for Blue only) divisions to brigades. At each step except division to brigade, the model can delay some number of cycles to represent time required for transportation and handling. The model can automatically lengthen the delay time when a friendly air environment does not exist. By input data, assimilation of received resource units at the brigade level can be spread out in any desired pattern over a period of up to 10 division cycles.

7. CONAF EVALUATION MODEL (CEM)--OPERATION:

a. In the preprocessing phase prior to a run of the CEM, pertinent characteristics and capabilities of forces to be simulated, organizational relationships, unit locations on the battlefield, and the battlefield itself are transformed into numerical data that are input for the computer program. Using these input data and the rules that comprise the bulk of the program, the CEM then simulates theater warfare until an arbitrary number of days have been simulated or until some portion of the FEBA has reached a predetermined location on the battlefield, whichever occurs first.

b. A major portion of the operation of the CEM is devoted to decision procedures intended to represent estimates of the situation. Decisions may affect the distribution of resource units, the commitment or retention of reserve units, the assignment of newly arrived reinforcing units, the allocation of CAS and artillery, and the mission or posture to be adopted during the ensuing time period. Decisions are made by each side on the basis of knowledge of its own forces and estimations of the enemy's forces and missions.

c. A decision procedure is completed cyclicly throughout a run of the CEM at each of four echelons: theater, army, corps, and division. Decisions are made every 12 hours at division level, every 24 hours at corps, every 48 hours at army, and every 96 hours at the theater.

(1) Theater-Level Decisions. The first event in a run of the CEM is theater-level decisionmaking. Three major decisions are made.

(a) Newly available reinforcement artillery battalions, whose arrival in the theater is determined by a schedule which is input for the CEM program, are allocated to armies in proportion to the numbers of divisions in the armies.

(b) Newly available resource units, also from an input schedule, are allocated to armies in proportion to their needs based on current unit state deficiencies of the divisions composing each army.

(c) Aircraft available for CAS are allocated to armies in proportion to the numbers of divisions in the armies.

Each of these decisions at theater level is based on friendly force characteristics without regard to enemy forces.

(2) Army-Level Decisions:

(a) At army level and below, opposing enemy forces are a factor in the decision process. The first decision determines where newly arrived reinforcements are assigned. All reinforcements other than artillery battalions arrive as divisions, and their arrival time (an input to the program) is the army period when they become effective. Such divisions are allocated to corps on a priority system based on corps' missions during the preceding corps period and force ratios. A corps that is delaying has first priority; one that is attacking has second priority. In each case, if more than one corps have the same mission, the reinforcing division is assigned to support strength on offense and weakness on defense.

(b) After reinforcing divisions have been allocated, each army selects its mission on the basis of its force ratio. Force ratios are formed for the entire army front. They are based on the known firepower of the friendly forces and estimated firepower of opposing forces. Whether to adopt an attack, defend, or delay mission and whether to have a corps in reserve are based on comparisons between calculated force ratios and input force ratio thresholds. Eventually, a mission which is the most aggressive action that the decision process predicts can be successfully undertaken is selected.

(c) For purposes of allocating fire support (CAS, aerial field artillery) to corps, force ratios are calculated from the available friendly firepower and the estimated available enemy firepower. Available firepower is composed of on-line corps capable of undertaking the mission being considered plus associated artillery battalions. Allocations are made so as to strengthen the weakest areas when the army mission is delay or defend and to strengthen the strongest areas when the army mission is attack.

(d) Resource units available to an army are allocated to its corps on the same basis as they were allocated from theater level to army level, i.e., to each according to his need based on unit state deficiency.

(3) Corps Level Decision:

(a) Selection of a corps mission is the first decision in each corps cycle. The rationale and procedures are similar to those employed at army level except only units on the corps' frontage enter into calculations of force ratios.

(b) All corps artillery is allocated to divisions. The distribution of that artillery is determined by the corps' mission and the force ratios across each division front. CAS aircraft are similarly allocated.

(c) Resource units available at corps are allocated to divisions in proportion to their unit state deficiencies.

(4) Division Level Decisions:

(a) At theater, army, and corps levels the decision procedures for both Red and Blue are similar. At division level, because the Blue Force is resolved to brigades while the Red Force is not, the decision procedure is simpler for Red than for Blue. Only two decisions are made for a Red division: what posture to adopt and the degree of enhancement of direct support artillery.

(b) Each Blue division has to know what to do with three brigades, three direct support artillery battalions, and its general support artillery that is organic or has been allocated by the corps. The possibility of CAS is not considered in this decision process because the timely availability of aircraft is not certain.

(c) The CEM has been programed so that forces are aggressive but prudent. The first possibility considered in the division decision procedure is, therefore, an attack with two brigades on line (one in reserve) supported only by organic direct support artillery providing standard-level support. If the outcome of the forthcoming action is considered unsatisfactory, the model proceeds to consider various alternatives. The artillery firing rate may be increased; attached artillery can be summoned; and the reserve brigade can be committed. If no combination of these possibilities produces a satisfactory outcome, a defensive posture is considered, and so on to a delay posture.

(d) Determination of an appropriate posture and conditions is complicated because the outcomes of combat engagements are assessed for each brigade front and a given brigade may face elements of two or more enemy divisions with different missions. The division-level decision process is the major portion of the CEM program.

(5) Tactical Air Model Decision:

(a) Except for CAS operations the tactical air model (TAM) runs almost independently of the ground combat model (GCM). At the beginning of each theater period, all available aircraft are allocated among the four roles simulated--air defense, counterair, armed reconnaissance and interdiction, and CAS--on the basis of input data and results of operations during the preceding theater period. For aircraft assigned to each of the three roles other than CAS, the air model then goes through assessment cycles equivalent to the division cycles composing a theater cycle. In each assessment cycle sorties are flown, losses are determined, and inventories are reduced by the losses. Losses are not only aircraft, but also ground-based facilities and weapons such as surface-to-air missile (SAM) installations and air defense artillery.

(b) The presence or absence of a friendly air environment for each side is determined for use in the ground model in the ensuing theater cycle. The time required to move men and materiel from their arrival in the theater to their availability to the combat elements can be set by inputs to the program. Delays between allocation and availability are normal and presume a friendly air environment. The absence of a friendly air environment imposes additional delays.

(c) CAS, being more intimately related to action on the ground, is handled differently. After determining the average number of CAS squadrons that will be available, the CEM simulates their allocation from theater to armies, armies to corps, corps to divisions, and (for Blue only) divisions to brigades. The allocation policy is the same as for artillery, i.e., support strength if the mission is attack and weakness if the mission is defend.

(d) Each cycle involves new estimates of the situation and a possible change in mission. Therefore, during each army, corps, and division cycle decision procedure, the CAS squadrons available for the current theater cycle are reallocated in accordance with the revised estimate of the situation.

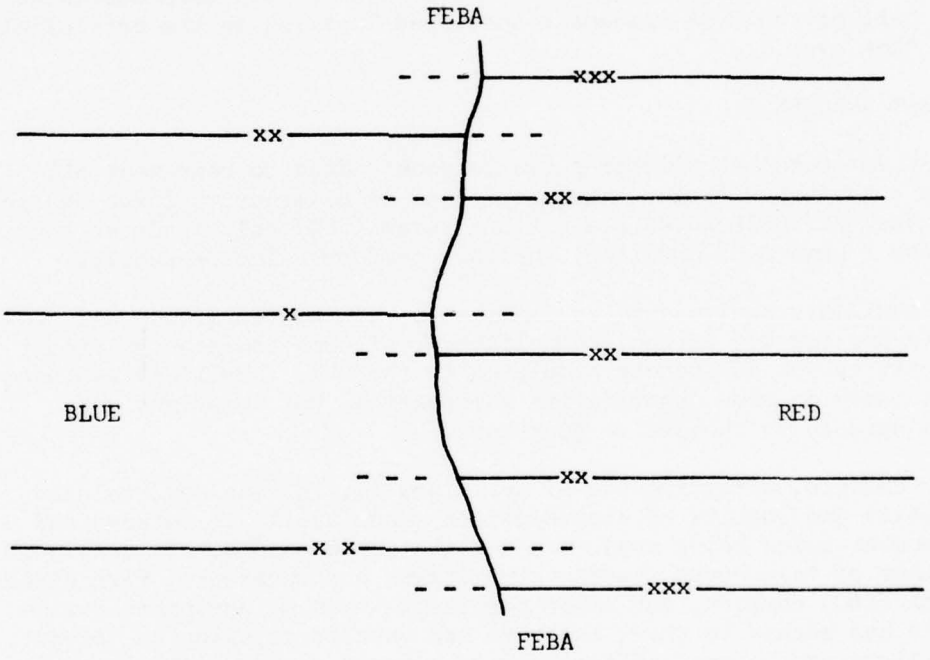
(e) At the end of each theater cycle, the attrition rate, i.e., aircraft lost with respect to number of sorties flown, for each role is determined for use in role allocations at the beginning of the next theater cycle. Then, available filler aircraft and replacement SAMs are added to the existing inventory, and the air model is ready for the next cycle.

8. ASSESSMENT OF COMBAT ENGAGEMENTS:

a. As a consequence of all decision processes heretofore described, each on line Red division and Blue brigade will have selected a mission

for the current division cycle and will have determined the combat support that it will have. These decisions, based partly on estimates of the enemy's ability and missions, are generally adopted with the expectation of success. However, knowledge of the enemy is incomplete and those expectations may not always be achieved. Therefore, the combat situation across each subsector of the FEBA is separately assessed and its outcome is determined.

b. Mission selection is based on each brigade front for Blue and each division front for Red. These are called sectors. However, unit boundaries of the two sides seldom aline with each other and adjacent units on one side may have different missions. The usual situation, therefore, is that a given unit on one side faces parts of two or more units on the other side. To insure unity of mission on each side, subsectors are defined as segments of the FEBA between adjacent organizational boundaries without regard to side. Engagement outcomes are assessed by subsectors, with the type of engagement defined by the missions of the opposing sides. (See fig 3-4.)



The Blue division has 2 sectors and 5 subsectors.
The Red corps has 4 sectors and 7 subsectors.

Figure 3-4 -- Sectors and subsectors

c. Engagement outcomes are separately assessed for each active subsector. An outcome is either decisive (one side wins, the other loses) or indecisive (neither side wins). This outcome, together with the type of engagement and type of terrain, determines the local movement of the FEBA.

d. An active engagement also results in reduction of the unit state values of the participating units. The number of unit state points lost depends on initial state values and on the engagement outcome.

e. After all subsector engagements have been assessed, the division cycle is repeated. Resource units are distributed and unit states are thereby increased; new estimates of the situation are made; reserve brigades may be put on line or on line brigades may be put in reserve; combat support elements are reallocated; and new engagement situations are created and assessed.

f. After each two-division cycles, the corps decision process is repeated. After each two corps-cycle, the army decision process is repeated. After each two-army cycles, the theater decision process and the air model decision process are repeated. This series of cycles continues until a predetermined number of theater cycles have been completed or until a part of the FEBA reaches a specified location on the battlefield. The run is then over.

9. AUXILIARY ANALYSES:

a. No theater combat simulator can be constructed to represent all potentially combat-significant characteristics of alternative force designs. Therefore, the RAC CONAF Force Evaluation System (FES) only includes the CEM, but also a number of auxiliary analyses performed independently.

b. An auxiliary analysis is an examination of the facilities and procedures intended for use in the accomplishment of some combat-significant military activity not adequately simulated in the CEM. Auxiliary analyses usually are based on some quantitative information, but sometimes they depend considerably on subjective judgments.

c. For example, effective use of artillery is, in some way, related to the quantity and quality of communication means available between and among the combat units being supported and the firing units. By considering the number of telephones, radio transmitters and receivers, fire direction control (FDC) centers, and other pertinent items of equipment available and who has access to them, analysts can develop opinions on to what degree artillery can be used effectively to support combat units in various situations. Changes in communication facilities and procedures may then be related to changes in artillery effectiveness.

d. Arriving at justifiable conclusions is difficult. To illustrate, if having two communication channels is considered twice as good as having just one, does it follow that four would be twice as good as two? Or might four degrade efficiency by permitting so much information to be received that additional time would be required to make decisions that would not be needed if less information were available? What are the effects of changes in the logistic systems; changes in the number, variety, or distribution of nonweapon items of equipment; or changes in administrative organization? These and similar questions must currently be treated by auxiliary analyses.

10. APPLICATIONS OF THE SYSTEM:

a. Results of 58 runs of the CEM and some auxiliary analyses are presented and discussed in volume II, Applications RAC report. Forty-six applications were sensitivity runs intended to reveal effects attributable to selected variations in rules or input data and 12 were classified as evaluations of CONAF alternative forces.

b. The forces simulated were a baseline force, which is similar to the current US 7th Army, and 11 alternative forces constructed according to two concepts of what might be feasible in the late 1970's. Concept I forces consist of six alternatives identified as I A through I F. Their mission is to hold or delay against an attack long enough to permit reinforcements to arrive. The percentages in each alternative of various kinds of maneuver units and/or models of equipment make one alternative different from another. For example, one alternative may have tank battalions as two-thirds of its maneuver battalions with mechanized infantry as the other third; another may have these proportions reversed; one force may have M60A1 tanks and another the new main battle tank (MBT); some alternatives have more combat engineers or more helicopters than others; and so forth.

c. Concept II forces consist of alternatives II A through II E.

d. The Red Force and the tactical air forces of both sides remained the same for all runs. To have varied more than just the Blue ground forces would have made relating the causes and effects difficult.

e. Results of an evaluation run are given in terms of FEBA movement over time and average unit states. No single force appeared best in terms of all measurement.

f. Forty-six sensitivity runs were made to determine whether differences in results reflect changes in the forces or merely to-be-expected consequences of the CEM logic. In each sensitivity run, the value of some input or some aspect of a decision rule in the model was changed. The results from the run then were compared with the results from a reference run. In theory, if a sufficient number of sensitivity runs were made, it should be possible

to identify and measure cause-effect relationahips between input or rule changes and results. In practice, this capability is somewhat limited because of an effect that is called "noise."

g. The CEM is a deterministic model; nothing in it occurs by chance. If no changes are made, a subsequent run will produce results identical with those of an initial run. However, it does contain decision thresholds involving unit state values and force ratios. These thresholds, among other things, determine mission selection and whether a reserve exists or is committed. These are yes or no decisions. A unit is either fully committed or fully in reserve; it cannot be partially committed or partially in reserve. Thus, if a unit state or a force ratio is close to a threshold, a small change in its value can significantly change a decision. And a changed decision early in a sensitivity run can lead to outcomes significantly different from those of the reference run. Sorting out effects attributable to an intentional change in data from those attributable to model design has proved difficult and the consequent obscurity between cause and effect is what is called noise. Some improvements planned for the CEM are directed toward reducing noise in the model.

h. Auxiliary analyses associated with these initial, experimental applications of the CEM to the evaluation of CONAF alternative forces were mainly concerned with command, control, and communication capabilities. The general conclusions were that the capability to perform these functions would be adequate and variations from alternative to alternative are not great. Consideration also was given to comparing airmobile assault potentials primarily was based on counts of helicopters and engineer equipment.

i. In summary, initial applications of the CEM have:

(1) Shown that it can produce information that may be useful in demonstrating differences in the combat capability of large military land forces as a function of their composition and equipment.

(2) Shown that, because of noise in the model, it is currently difficult, in a single run, to discern with confidence a different performance level for forces that are close to each other in combat capability.

(3) Revealed a number of improvements that can and should be made to the model. These are discussed in volume IV, System Improvement Program.

11. SYSTEM IMPROVEMENT PROGRAM:

a. Development of the CONAF CEM was intentionally halted to permit its use in the evaluation of selected alternative force designs during RAC's first year of participation in Project CONAF. At that time and subsequently,

as the model was used to analyze various force designs provided by the Army, it was apparent that a number of improvements could and should be made in the model.

b. A fully computerized theater war simulation model such as the CEM is complex. Making changes to that type of model involves different types of effort. Some changes are simple and easy to accomplish while others are difficult, to the point of being equivalent to the creation of a new model. The value of a proposed change, in terms of increased realism or improved utility of the model, is not proportionate to the effort required to make the change.

c. Two types of effort are required. First, a model designer must, in clear and unambiguous terms, describe the action to be simulated and all its interrelationships with other components of the model. His product essentially is a set of rules. Second, a programer must translate these rules into the appropriate programing language and fit the result into the existing program. He must insure that only desired changes are effected and that no inadvertent interference occurs in other parts of the program. Without actually accomplishing a change, the programer has difficulty predicting the effort required in all but trival cases.

d. Based on judgments of the effort required to make each change and its probable value as an improvement, the 29 proposed improvements presented in volume IV, RAC report have been grouped into six sets of from two to 11 improvements each. Two reasons for so grouping the improvements are:

(1) Some improvements are related and some are unrelated. Generally, improvements within a set are related and sets are unrelated.

(2) Because the model is so complex, if too many changes are introduced simultaneously, keeping track of the interactions in the model is difficult. The plan, therefore, is to completely program, test, and debug all the changes in one set before proceeding to the next set.

e. Set 1 primarily is directed toward increasing the realism of the existing model. Set 2 improvements also will enhance the model's realism; but, more importantly, they will increase the detail with which logistic activities are simulated. Set 3 will change the handling of reserve divisions and add the ability to selectively simulate the special capabilities of barrier and denial divisions. Set 4 will improve the corps and army level decision processes and improve the treatment of exposed flanks and unit boundaries. Set 5 will expand and improve the simulation of artillery.

f. The changes in set 6 are classified as deferred. This does not mean that they could not be done or that they are not important. However, to expect to accomplish all 29 proposed improvements in the next year is

clearly unrealistic. Therefore, on the basis of judgments on required effort and anticipated value, the proposed changes in set 6 were set aside for future consideration. Some of them virtually are equivalent, in complexity, to the creation of a new model.

APPENDIX A

MODELS

1. INTRODUCTION. This appendix provides detail to the model summary presented in section II. It addresses both force costing and force planning models.

2. FORCE-COSTING MODELS:

a. Modular Force Planning System (Battalion Slice).

(1) General. This is the principal planning tool which, though able to provide costs for combat modules, is incapable of providing costs for individual support units. The costs for support are an aggregated amount for the entire force.

(2) Use. The battalion slice model was used for two purposes in the CONAF study. First, in preparing alternatives it was used by the designer to assist in prorating support elements to the combat elements in each design. Second, it was used to assist in the evaluation process by highlighting the degree of support provided for the following combat support and combat service support functions: supply and maintenance; engineer; transportation; and medical.

(a) The battalion slice model was exercised with the combat elements of each design. The "unconstrained" results were examined to determine a full "requirement" for organization for each listed function.

(b) Each actual design was examined to determine the organizations provided for each of the listed functions.

(c) The organizations were reduced to personnel numbers and then to ratios by dividing the actual design numbers by the theoretical requirements (battalion slice).

(d) The ratios for the designs were then compared with similar ratios developed for the approved baseline force. The resulting differences were used to compare the sustainability of an alternative design as compared to the baseline force.

(e) The calculations and comparisons are given in volume VIII.

b. The Force Cost Assessor (FCA). This is a component of the FOREWON system of models and thus required input from this system of models. The FOREWON system is an automated force planning system composed of simulation, wargaming, roundout and cost models. Because of its size and inputs it would be impracticable to use only part of the program. Another disadvantage is that the FCA does not compute the total costs of a force.

c. Joint Strategic Operation Plan (JSOP) Model. This model is basically a total-manpower model which provides the cost per man year for various cost categories by fiscal year. RDTE, MPA, and MCA costs are used only as throughputs. This model was considered too restrictive for costing the CONAF forces.

d. Cost-Factoring System for Readiness Projection (COFACTS). Principally the model examines the impact of readiness levels of future forces. In so doing it relates these forces to the Army budget. The model in October 1970 was limited to developing costs for total force or major command levels and not for individual units.

e. DOD Electric FYDP Model. This model is the forerunner of the Army's Mark Twain Model; it provides the Secretary of Defense a capability for analyzing costs of the Armed Services. This model provides adequate detail for the OSD level, but the detail is inadequate for the service level. Because of this, each of the services (with the assistance of OSD) is developing a similar model sufficient for their needs. The Army's model is discussed below.

f. Electric FYDP/Mark Twain. This model provides a rapid capability for analyzing resource requirements. The system is an input/output type model and generates costs for direct and indirect support for all units as well as combat type units. This version of the Electric FYDP Family has one of the strongest logistics support sections of any of the models used by the services. The model also has a provision to allocate personnel resources throughout the Army. The model normally takes five hours for a single iteration.

g. Resource Requirements and Precombat Capabilities Model (RECAP). This model provides a rapid means for comparing alternative combat unit configurations on the basis of some 55 different force measures. The model provides, in part, resource consumption and precombat capabilities of battalion sized units. Very little cost data can be derived from this model; it is principally a force planning model permitting the user to evaluate various alternatives of force structure.

h. Resource Related Planning System (RRPS - Dean Model). This system is a series of decision models that allows the user to match budget constraints with equipment requirements through the use of a cathode ray tube (CRT) display facility. A printout of the comparisons model can be attained. The system provides a means for rapidly evaluating the effect of budget constraints on equipment acquisitions; personnel acquisitions and force structure changes over a 10-year period. Inputs are a projected 10-year Army budget (according to appropriation category breakouts), projected 10-year Army equipment and personnel requirements, and specific cost factors associated with asset procurement and maintenance. The model is incapable of handling the distribution of equipment by theater. The model is suitable for comparing the total cost of a force with the result from another model. This model is also useful

in evaluating the effects of budget constraints on equipment and personnel acquisitions and force structure changes. This latter capability will be useful in trade-off analysis. The computer running time is about 30 minutes.

i. COSTALS Model. The COSTALS Model was examined in detail, and was the one eventually chosen for force costing. This model has several advantages over other similar force costing models. One is an operational interface between the Modular Force Planning System and the FOREWON series of models. Another advantage is that very little additional information is needed as input to the computer program. In preparing input for the program the analyst needs only to determine whether the standard requirement code (SRC) for a type unit is in the data bank.[1] If the SRC is in the data bank, the only effort required is to include the SRC on the input material along with the number of such units in the force. If the SRC is not in the COSTALS data bank, the analyst may either find a similar SRC that is in the data bank, or he must develop appropriate costs by other methods on a comparable basis. Many units were costed by tedious manual calculations during the CONAF study. A model developed by OCA is being examined and refined to automate the process. The outputs from the COSTALS Model are cost estimates for units by SRC or a cost estimate for any combination of units. The costs are provided for the unit's initial investment and annual operating costs in 32 different cost categories. Also, initial and annual cost totals are provided for OMA, MPA, and PEMA appropriation categories under peacetime conditions for five theaters. The costs for each unit in the force package are then totaled, with consideration of the unit strengths and the quantities of each type of unit in a given force, to get the total initial and annual force costs. This model was selected for developing the 10-year systems costs for comparative purposes.

3. FORCE-PLANNING MODELS:

a. Interface with COSTALS. All of the above models were examined to select the best model to aid in developing the forces. Since the COSTALS Model was selected for the force costing, it was necessary to select some model that would interface easily, and would develop comparable support elements to provide a full division force equivalent.

b. Modular Force Planning System. The force planning model that best met the above criteria was the modular force planning system of battalion slice model. This model can develop "required" support elements and also make theater strength determinations. The output depends upon the combat elements which were inputted by force planners. The model computes the total support troop list for a given theater of operations under fixed ratio assumptions. Units enter the force list by one or more different methods.

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[1]The SRC is a 12-position code which identifies the basic TOE and any variation. This code is designed to facilitate the handling of TOE data through ADP means.

(1) They can enter through the support-to-user, or support-to-supporter matrices. These matrices constitute the heart of the model, and the bulk of the units on a given troop list enter the force list in this manner.

(2) Units can also enter the force list via a series of scenario-oriented parametric (or workload) routines.

(3) They may be hand-inputted by the force planner. Outputs include a completely structured support troop list and the associated theater personnel, tonnage, cubage and cost summaries.

c. SACS Model. As a supplementary model, or system, the structure and composition system (SACS) initially was selected to aid in developing the conceptual forces. This model is capable of accepting the force list developed by the battalion slice and printing out the equipment by line item and quantity and the manpower by branch, rank, and military occupational specialty (MOS) that the force will require 100 percent fill. The model's principal disadvantage is that the system will not accept conceptual units with a G-series or earlier TOE. Another disadvantage was that the information in the unit identification code (UIC) portion of the data bank appeared not to have been purified; consequently, when trial runs were made, much time was spent attempting to get certain results on certain UIC units that were in being; but data apparently were not in the data bank. Because of these troubles, the SACS use in the analysis was limited.

APPENDIX B

COST MODEL REQUIREMENTS

1. MODEL CHARACTERISTICS:

a. Does model do total force and life cycle costing by year?

b. Does model cost only incremental costing?

c. Does model include time phasing?

d. Is model capable of sensitivity analysis?

e. Can model cost different geographical variations at the same time?

f. Does model have capability for costing reserve and unmanned units in addition to active units?

g. Can model cost increments of TOE's, 90 percent, etc?

h. What type of costing technique? (Engineering estimate, Analog, cost factor, and CER)

i. How do we cost our baseline force? (G-series TOE)

j. Will model cost conceptual force design, by year?

k. Can model handle inherited assets?

l. Can model handle discounting?

2. INPUT:

a. Are any throughputs required?

b. What are the required inputs?

c. Can input be modified without major effort?

3. OUTPUT:

a. Total costs over 10-year period, by year, by theater.

b. By appropriation categories (PEMA, OMA, MPA, MCA, and R&D), and also by investment and operating costs.

c. Lower level than appropriation categories, and if so, what level?

4. DATA BASE:

a. What would effect be on data base to establish our baseline cost? (What magnitude of effort?)

5. MODEL OPERATIONS:

a. What type computer is used?

b. Where is computer located?

c. How long for a run?

d. Who do we contact to get the computer program?

e. Who do we contact to arrange for a computer run?

f. What services can they provide? (Changes in program, input and data base.)

APPENDIX C

NEW-UNIT COST MODEL[1]

1. BACKGROUND. The New-Unit Cost Model was originally developed by the COA as a means of providing relatively rapid gross costing of new units which are similar[2] to currently existing TOE units. It was used to cost Army Strategic and Tactical Reorganization objective (ASTRO) organizations and was structured to emphasize the cost of major equipment. After obtaining information pertaining to the model from COA, such as the program and punch card deck, it was recognized that modifications and additions to the model were required. These changes were necessary to make the New-Unit Model compatible to the COSTALS Model; to expand and restructure the model to make it more flexible; and, to include cost elements in investment cost that had been omitted from the original model. This phase of the model development has been completed. The model has been tested and found suitable for use in gross costing. It is programed in FORTRAN for use on the HQ, USACDC IBM 360-30 computer. The following paragraphs indicate the approximate percentage of the CONFOR GP-developed CONAF conceptual units which could be costed by use of the New-Unit Model and explain the model inputs, operations, and outputs.

2. CATEGORIES OF CONCEPTUAL UNIT DESIGNS. CONFOR GP conceptual unit designs fall into three categories relative to existing units: (1) identical units, (2) similar units and (3) no-match units. Analysis of the units in various CONAF alternatives indicates that approximately 50 percent of the units were identical to existing TOE's, 35 percent were similar to existing TOE, and 15 percent were no-match units. Thus, the New-Unit Cost Model could be utilized for costing about one-third of the CONFOR GP's planned units.

3. TYPES OF INPUT DATA. There are three basic types of input data required for the organizational unit to be costed. These are (1) major items of equipment, (2) dependent factors (DFAC), which are inputs taken from the known or similar unit and (3) factors (FAC), which are theater-oriented per-capita factors.

a. The major-item-of-equipment input requirements for the unit to be costed include Line-Item Number (LIN), nomenclature, unit price, quantity and BP-2000[3] (aircraft only) /BP-2300 costs for each major item of equipment

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[1]The information concerning cost elements and categories in this model is current as of April 1971. This information does not reflect up-to-date changes in the COSTALS Model and the Army Force Planning Cost Handbook.

[2]Similar units are defined as those units which do not differ significantly from existing TOE units in function, personnel strength, and type of equipment.

[3]BP 2000 and other similar type costs are no longer part of the COSTALS output. The New-Unit Model would have to be modified to accommodate these changes.

the number of officers and enlisted men in the new unit. The equipment LIN, nomenclature and equipment quantity plus personnel numbers were furnished by CONFOR GP in the unit reference sheets. The SA Group developed a data bank of about 400 existing major-equipment items. This data bank includes the equipment procurement unit cost by LIN and nomenclature and a cost factor for equipment depot maintenance (BP 2300) plus an operations and maintenance factor (BP 2000) for aircraft. In addition the USAMC provided (through COA) cost information on developmental items.

b. The input requirements for the similar units are total major equipment PEMA costs, the total number of personnel in the unit, plus the DFAC. The DFAC are other PEMA, OMA, and MPA investment and operating cost which are dependent upon type of unit. A percentage factor (dependent upon the type of unit) must be included to calculate the cost of miscellaneous initial equipment. The PEMA-related recurring DFAC include major equipment replacement costs, secondary items replacement costs, costs for training ammunition and missiles, and the PEMA portion of personnel replacement costs. The OMA DFAC include the unit and base operations cost factors by theater and the OMA portion of personnel replacement costs. The MPA DFAC is the MPA portion of personnel replacement costs. The FAC are basically OMA and MPA per-capita cost factors which are independent of type unit but vary by theater. These factors include Central Supply (BP 2200), Medical Activities (BP 2400), Army-wide Activities (BP 2500), and officers and enlisted men pay and allowances and PCS factors.

4. INTERNAL ACTIONS. The model compares the new-unit and similar-unit inputs and determines the correct personnel and PEMA ratios for the new unit versus the similar unit. The model then calculates initial PEMA, OMA, and MPA battalion costs. The battalion costs are then added into corresponding cost-category sums in the division summary for the number of battalions of this type. The model then checks to see whether the last battalion that was costed was the last battalion of this type in the division. If the answer is yes, all division costs are calculated. If not, it goes back and repeats the process until all similar type battalions have been costed. When all have been costed, the model prints a list of the total quantity of each LIN used in the division.

5. OUTPUTS. The model outputs are in the form of initial investment costs and annual recurring costs by theater of operation (as indicated in figure C-1). The initial investment costs are broken down into initial major equipment, other initial equipment, OMA, and MPA categories; the output includes an overall total. The annual recurring costs are also broken down into the above categories plus an additional category for military personnel replacement costs. These categories, in turn, are further subdivided. The PEMA category includes a cost for replacement of major TOE equipment, replacement of secondary items, training ammunition, and training missiles. The OMA category is subdivided into base operations, unit operations, BP2000/BP2300 for aircraft operations, central supply, depot maintenance activites, medical activities, and Army-wide activities. The MPA category includes pay and allowances and PCS for officers and enlisted men. The military personnel replacement cost is subdivided into PEMA, OMA, and MPA elements.

SAMPLE NEW-UNIT COST MODEL OUTPUT

SRC 073571102000 Aviation Company (Assault Helicopter)

(1) Strength 462.

Officers	130
Enlisted Men	332

(2) Initial Costs	CONUS 27,376	W. EUROPE 27,832
Initial Major Equipment Costs	17,925	17,925
Other Equipment Costs	2,868	2,868
Initial OMA Costs	2,832	2,985
Initial MPA Costs	3,751	4,075
(3) Cost by Category	Annual Recurring ($000)	
PEMA		
Replace Major TOE Equipment	743.	743.
Replace Secondary Item	591.	591.
Training Ammunition	0.	0.
Training Missiles	0.	0.
OMA		
Unit Operations	379.	379.
Base Operations	568.	596.
Aircraft Operations BP 2000	903.	903.
Aircraft Operations BP 2300	1,389.	1,389.
Central Supply	88.	286.
Depot Materiel Maintenance	78.	78.

Figure C-1--Sample new-unit cost model output (continued on next page)

	CONUS	W. EUROPE
Medical Activities	96.	66.
Army-Wide Activities	5.	59.
MPA		
Pay-Officers	1,681.	1,721.
Pay-Enlisted Men	1,488.	1,573.
PCS-Officers	41.	166.
PCS-Enlisted Men	24.	176.
Military Personnel Replacement Cost		
PEMA	42.	42.
OMA	439.	439.
MPA	672.	672.
(4) Total Annual Recurring Cost	9,227.	9,898.
PEMA	1,376.	1,376.
OMA	3,945.	4,213
MPA	3,906.	4,309.

Figure C-1--Sample new-unit cost model output (concluded)

6. MODEL ADVANTAGES AND DISADVANTAGES. There are two basic advantages to using the new-unit cost model where it is applicable. First, it has been structured to use COSTALS data as input. This fact is significant since the COSTALS Model has official Army recognition. Second, the FAC (see paragraph 3b for description) are applicable to all units. Its basic disadvantage is that a new set of DFAC (see paragraph 3b) must be developed for each distinct type of unit to be costed.

APPENDIX D

ARMY AND MARINE CORPS FORCE CLASSIFICATION SYSTEM

Summary of Code Designators

FIRST POSITION
(Category)

A - Division Forces
B - Special Mission Forces
C - General Support Forces
D - Individuals

SECOND POSITION (Force Package)	THIRD POSITION (Location/Orientation)
A - CONUS Air Defense	A - Alaska
B -	B - Berlin
C - Strategic Communications	C - CONUS
D - Defense Force	D - Caribbean
E - Combat Developments	E - Europe
F - Free World Support	F - Africa
G - Other Service Support	G - Greenland
H - Headquarters and Field Activities	H - Hawaii
I - Strategic Intelligence and Security	I - Iceland
J - DOD and Joint Activities	J - Japan
K - Movements Support	K - Korea
L - Logistic Establishment	L -
M - Missile Force	M - Middle East
N - NATO Force	N - Reforger (Temporary)
O - Theater Support	O - Okinawa
P - Pacific Force	P - Panama
Q -	Q - Pacific
R - Research and Development	R - South America
S - Support Establishment	S - SE Asia
T - Training Establishment	T - Thailand
U - Unmanned Strategic Reserve Force	U -
V - Strategic Reserve Force	V - Vietnam
W -	W -
X -	X - Worldwide
Y -	Y -
Z - Other Theater Force	Z -

APPENDIX E

EXPLANATION OF COST ELEMENTS

1. GENERAL. This appendix provides an explanation of the elements that comprise the PEMA, OMA, and MPA appropriation categories that are listed in Section 5 of this chapter.

2. INITIAL INVESTMENT - PEMA. The elements which comprise the PEMA category for initial investment costs are major equipment, operational readiness float, repair cycle float, repair parts, and accession and training.

a. PEMA major equipment costs are the total costs of the initial allowances of equipment prescribed in the unit TOE and procurred with PEMA funds. These costs are computed by multiplying the TOE allowance for each equipment line item by the standard price of the itme as listed in Supply Bulletin (SB) 700-20.

b. Operational-readiness-float items are defined as those end items of mission essential, maintenance-significant equipment authorized for stockage by maintenance-support units to replace unserviceable equipment to meet operational commitments. The costs are computed by multiplying factors in the authorization line-item (LIN) cross reference file by the cost of the TOE initial allowances for each item.

c. The repair-cycle float is an additional quantity of end items of mission-essential, maintenance-significant equipment specified for stockage in the supply system to permit withdrawal of equipment from organizations for scheduled overhaul without detracting from the unit's readiness condition. The cost computation is the same as for the operational-readiness-float items.

d. The cost of PEMA repair parts if the cost of the initial procurement of repair parts and other secondary items, but not included above. Based on analyses of the PEMA appropriation, repair-parts costs are estimated at an average of seven percent of the total for major equipment, operational readiness float, and repair-cycle float.

e. PEMA accession and training costs include the training-ammo costs computed from Tables of Authorization (TA) on a per trainee basis and similar costs for demonstrations and exercises.

3. INITIAL INVESTMENT-OMA. The elements which comprise the OMA category of initial investment costs are repair parts, minor equipment, station equipment, organizational clothing, Programs 4 and 7S and the OMA portion of accession and training.

a. The OMA repair-parts costs are those costs of the initial procurement of the Prescribed Load List (PLL) repair parts bought with OMA funds. PLL repair parts are those authorized by major commanders to be on hand in units for organic maintenance of assigned equipment. The PLL is carried by the individual or on unit transportation and enables the unit to sustain itself during combat operations until resupply can be effected.

b. The OMA minor equipment costs are the costs of initial allowances of TOE items procured with OMA funds either directly or from the Army stock fund.

c. The OMA station equipment costs cover the costs of furniture and furnishings for quarters as authorized by appropriate TA.

d. The OMA organizational clothing costs cover the initial purchases from OMA funds for items authorized in appropriate TA.

e. OMA programs 4 and 7S are central supply activities. The costs for these programs include procurement operations, processing, storing, issuing and transporting initial equipment from CONUS depots to the using unit plus the costs to fill supply pipeline levels. These costs are determined either on a tonnage or a per capita basis, as applicable.

f. The OMA portion of accession and training costs includes training mission costs, the cost of operation and maintenance of training facilities, and the support costs of central supply, depot maintenance, medical activities, and finance services.

4. INITIAL INVESTMENT - MPA. The elements which comprise the MPA category for initial investment costs are the MPA portion of accession and training and the initial permanent change of station (PCS) costs. The MPA portion of accession and training costs includes pay, basic allowance for quarters, subsistence, clothing, and other minor charges for each trainee. In addition, it includes a prorated share of the pay and allowances and applicable PCS for instructors and post military overhead. Initial PCS costs for a force unit include travel from schools or training centers to the unit activation location in CONUS for total TOE strengths at CONUS rates. In addition, units deployed to overseas areas include variable PCS costs of travel for the total TOE strength from the activation location in CONUS to the permanent location of the unit in an oversea area.

5. ANNUAL OPERATING - PEMA. The elements which comprise the PEMA category for annual operating costs are major equipment replacement, repair parts, ammunition and missiles, and the PEMA portion of accession and training costs.

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CONCEPTUAL DESIGN FOR THE ARMY IN THE FIELD (CONAF). PHASE I. V--ETC(U)
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a. Major equipment costs are the annual PEMA force unit's major TOE equipment. These costs ar Replacement Factors (PRF) for equipment line item a function of equipment type. The factors are ap TOE initial allowances for each line item.

b. The annual PEMA repair parts costs are es Operating Cost Agency to be an average of three p investment costs for TOE major equipment, operati repair cycle float.

c. Annual PEMA ammo and missile costs are th fired by the force unit during annual service pra

d. Annual accession and training costs are t curing and training of the replacements necessary of a force unit at full TOE strength. The PEMA p applying the appropriate EM and Officer attrition PEMA cost for accession and training.

6. ANNUAL OPERATING - OMA. The elements which c for annual operating costs are Programs 1 and 2, operations, Programs 4, 7M, 7S, 8M, 80 and 9, plu annual accession and training.

a. The costs of OMA Programs 1 or 2 are the force units, except aircraft. The costs are comp per-man-year factor to the total TOE strength and the initial major TOE equipment cost. These fact operations.

b. The OMA base operations costs are the ann operations in support of force units, less instal craft operations. The costs are computed by appl factor to the total TOE strength. This factor va tions.

c. OMA aircraft operations costs are the cos tion of the aircraft in force units. These costs the numbers and models of aircraft in the TOE and and the costs per flying hour.

d. Central supply activities costs (OMA Prog annual costs related to force-unit supplies consu include second destination transportation, the va ment operations, supply depot operations, supply post operations. The man-year costs vary by thea

e. Depot Materiel Maintenance Costs (OMA Program 7M) are the annual costs of depot maintenance of the force unit equipment. These costs are computed separately for four different types of equipment items: (1) aircraft, (2) specified items, (3) unspecified items, and (4) not overhauled.

f. Medical activities costs (OMA Program 8M) are the annual costs of medical services that can be related to military personnel of the force unit. The factors are determined on a per-man-year basis and are applied to the total TOE strength. The factors vary by theater of operations.

g. Other general personnel activities costs (OMA Program 80) are the variable costs of personnel support type activities. They are determined on a per-man-year basis and are significantly higher in Europe than in other theaters of operations because the European costs include the costs of schools for dependents.

h. As indicated previously, annual accession and training costs are the recurring costs of procuring and training of the replacements necessary to maintain the strength of a force unit at full TOE strength. The OMA portion is obtained by applying the appropriate EM and Officer attrition factors to initial OMA cost for accession and training.

7. ANNUAL OPERATING - MPA. The elements which comprise the MPA category for annual operating costs are MPA accession and training, MPA (excluding PCS), and PCS.

a. In addition to a portion of the annual accession and training costs, the MPA category also includes the costs of separation travel and payments for unit personnel attrition from the Army. Separation costs are computed by multiplying the TOE officer and enlisted strength by the appropriate per capita costs and applying the attrition factors.

b. MPA (excluding PCS) includes the military personnel costs for the manpower of the force unit. The costs include base pay and allowances, plus special pay for pilots, paratroopers and doctors, as appropriate.

c. PCS costs are for permanent-change-of-station(PCS) travel. They are paid from MPS funds. PCS travel is computed by combining the appropriate per capita cost factors and the appropriate annual attrition rates.

APPENDIX F

DEVELOPMENT OF CIVILIAN STRENGTHS

1. DEVELOPMENT OF TOTAL CIVILIAN STRENGTHS IN BASELINE FORCE.

a. For an analysis of civilian strength in any force, use the force or plan that is the most recent. This can be any of the following - Army Force Development Plan (AFDP), the Force Accounting System (FAS), or ACSFOR Report 128 (Manpower Subject to Department of the Army Manpower Voucher). The one preferred is probably ACSFOR report 128, since it is a machine run and is generated quarterly. In using any of these force reports, care must be exercised in using only those units that are specifically assigned to the force under consideration.

b. For the Baseline Force, the following procedure is recommended: Units in the force packages under consideration are extracted and listed in tabular form with their Troop Program Sequence Number (TPSN), Title, SRC, and the number of units. In addition, the military and civilian strengths are listed along with the closest TOE strength (to the CONAF design from CDC Pamphlet 310-4 (Reference Digest of Tables of Organization and Equipment - TOE.) The civilians strengths are then totaled; and this sum is used as the number of civilians in the Baseline Force.

2. The number of civilians in any concept was developed and costed by examining the troop list and extracting the civilians by category - direct and indirect hire (contract personnel). These categories were then totaled, and the aggregate strength was obtained. A manpower cost factor per theater was then applied to this total strength to obtain the total cost for civilians in each concept.

APPENDIX G

PREPOSITIONED MATERIEL CONFIGURED TO UNIT SETS (POMCUS)

1. The Deputy Chief of Staff for Logistics (DCSLOG) has identified certain reinforcing units of the Baseline Force for the European and Pacific Theaters for which selected materiel items are to be prepositioned. This program is known as POMCUS (Prepositioning of Materiel Configured to Unit Sets). Each alternative force package also identifies certain units to be equipped by the POMCUS program.

2. Computer programs were developed and used to identify the total POMCUS materiel requirements of the Baseline Force and each alternative. These programs identify POMCUS materiel requirements by type, quantity, and acquisition cost (except for certain high-cost, high-maintenance, low-storability items such as aircraft.)

3. The POMCUS equipment, as calculated for CONAF designs, includes maintenance-float materiel (based on the POMCUS unit's organic requirements. It does not include war-reserve materiel.

APPENDIX H

URS AND SRC MATERIEL - REQUIREMENTS AND DOLLAR - COST PROGRAMS

1. COMPUTER PROGRAMS. Two computer programs, one to organizational-unit materiel requirements by line item and one to determine dollar costs by line item, were developed. These computer programs were necessary to eliminate considerable man-hours of hand calculations for summation of line-item requirements and associated dollar costs. By assigning each line item a combat-function code, the percentages of materiel dollars assigned to each function could be computed rapidly.

2. COSTS. Dollar costs were obtained from Department of the Army Supply Bulletin 700-20 (SB 700-20) Army Adopted/Other Selected Items and List of Reportable Items, May 1971, effective 1 September 1971. For developmental items whose prices did not appear in SB 700-20, cost estimates were obtained from approved DA documents and publications. See Volume III, Chapter 5, Appendix B for a listing of sources. The Combat Function Code is depicted **in figure H-1.**

3. ACCUMULATED MATERIEL COSTS. URS and SRC units to be costed were inputted to each program on punched cards. The units were required to correspond to the units stored in the URS master file or the US Army Combat Developments Command TOE master file for the respective programs. Equipment which was authorized for the units selected from the master file, was matched to a LIN file. Matched LIN were then accumulated by quantity and dollar cost.

4. COMPUTER PROGRAM OUTPUTS. Both computer programs print the quantity of each LIN in each force and the total cost for each force. The URS program also provides a combat-function cost matrix and sums five force packages[1] to produce data on LIN quantity and total cost for each CONAF alternative.

5. FLOW CHARTS. Flow charts displaying the flow of each program as described in paragraph 3 and 4 above are depicted **in figure H-2 and figure H-3.**

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[1] These force packages are: (1) European, (2) European Reinforcing, (3) Strategic Reserve, (4) Pacific (-), and (5) Korea.

Combat Function Code

FUNCTION	A AIR	B MSL	C WPNS & CMB VEH	D TACT VEH	E COMM & ELCT	F OTHER
COMBAT						
a. Air Defense						
b. Air						
c. Infantry						
d. Artillery						
e. Armor						
f. Armored/Air Cavalry						
SUBTOTAL						
INTELLIGENCE						
a. Reconnaissance, Surveillance Target Acquisition						
b. Strategic						
c. Weather and Mapping						
d. Other						
SUBTOTAL						
3. CONTROL						
SUBTOTAL						
4. SUPPORT						
a. Construction						
b. Supply and Maintenance						
c. Personal						
d. Medical						
e. Transport						
f. Other						
SUBTOTAL						
COLUMN TOTAL						

Figure H-1--Combat function code

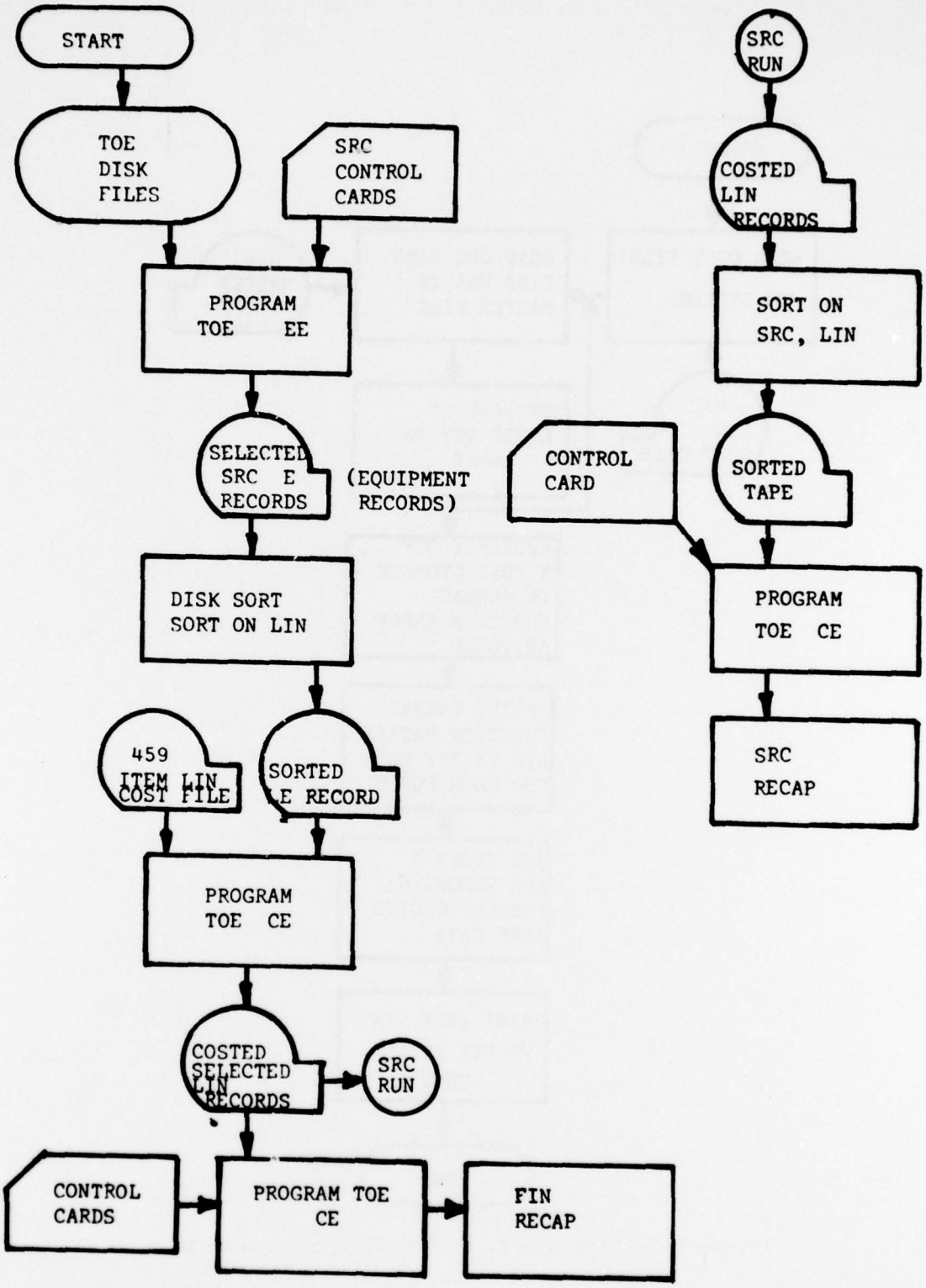

Figure H-2--Flow chart, TOE costing of equipment

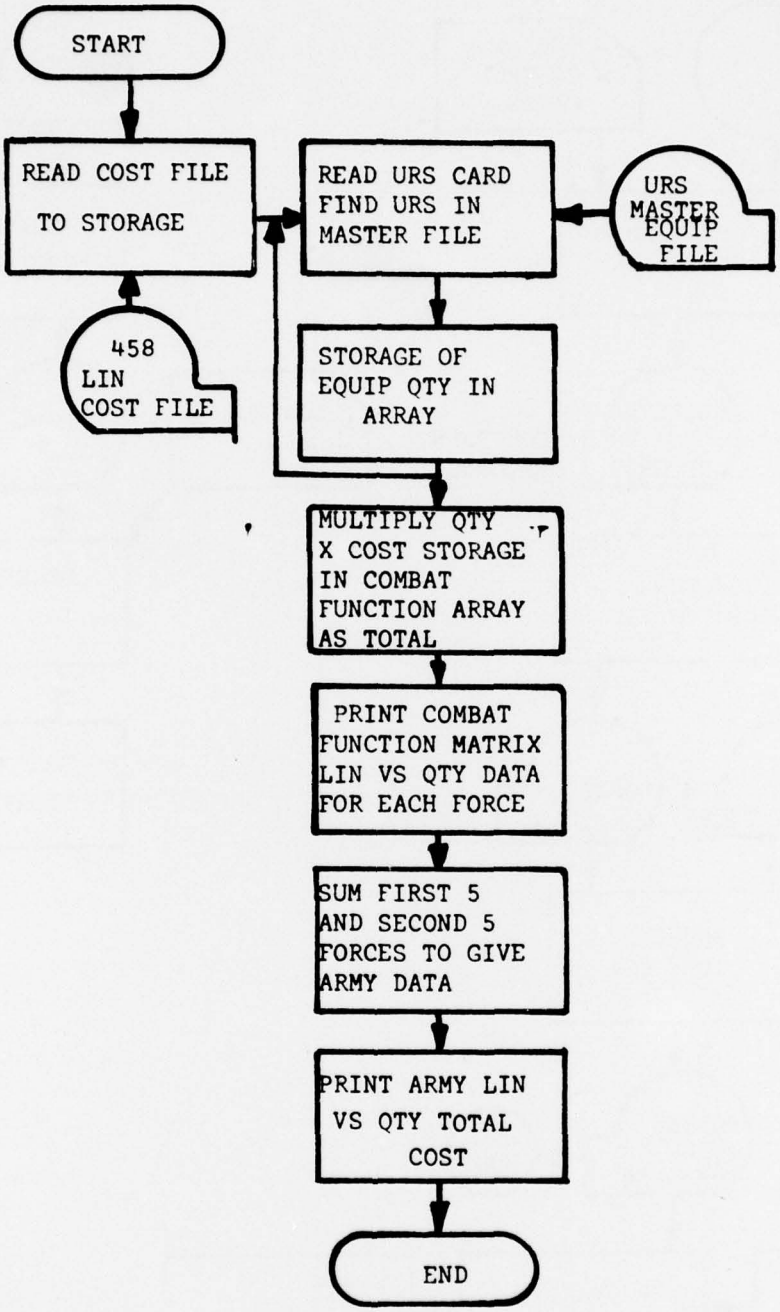

Figure H-3--Flow chart, URS costing of equipment

APPENDIX I

BACKGROUND STATEMENT

1. PROBLEM. Develop a computerized, theater warfare simulation model and apply it to a number alternative Army force organizations for the purpose of determining significant differences in their probable combat capabilitites.

2. FACTS:

a. Early in 1970 the Assistant Chief of Staff for Force Development (ACSFOR) tasked the US Army Combat Developments Command (USACDC) to develop a conceptual design for the Army in the field (CONAF) for the mid-range period. To do this, USACDC was to develop and evaluate alternative mixes of type organizations designed to achieve maximum combat effectiveness for reasonable projections of resources available during the period of interest.

b. Late in 1970, members of the CONAF Evaluation Assistance Group (CEAG), a monitoring and advisory committee for the project, visited the Research Analysis Corporation (RAC) to determine the feasibility of obtaining RAC's assistance. The project urgently needed help and was of first priority.

c. During December 1970 and January 1971, RAC rearranged its ongoing work year (WY) 1971 program and prepared a research plan for its participation in the CONAF project. RAC contracted to produce a means for evaluating alternative force designs and to apply those means to a number of force designs to be provided by the Army. Formal, contractual work began 1 February 1971 with an agreed interim completion date of 31 August 1971.

3. DISCUSSION:

a. From the beginning, the Army and RAC both understood that it was not feasible both to develop a fully acceptable theater force evaluation system and to apply it to the desired number of force alternatives in the time available. Fortunately, RAC had a nascent theater combat model (TCM) which was considered suitable, with modifications, as in interim CONAF evaluation model (CEM). Army agreed to give priority to making necessary and desirable modifications to the TCM up to a fixed date. After that date, the modified TCM (renamed the CEM) would be used to evaluate Army-supplied alternative force structures. A report covering work accomplished and additional desirable modifications for the CEM was to be available by 31 August 1971.

b. All work was accomplished as planned except for the submission of the completed report. The report comprises four volumes.

(1) Volume I is a nontechnical summary of the entire RAC-CONAF work.

(2) Volume II, Methodology, is a complete description of the Theater Force Evaluation System for CONAF developed by RAC. It was completed and delivered to the Study Advisory Group (SAG) for review on 31 August 1971.

(3) Volume III, Applications, describes and presents the results of RAC's evaluations of Army-supplied alternative force structures and certain sensitivity and investigatory applications of the CEM.

(4) Volume IV, System Improvement Program, is a grouped listing of improvements that might be made to the CEM.

c. Because the Army desired a more complete evaluation of "Applications" than would have been possible by 31 August, it extended the report completion date to 30 November 1971. Submission of volumes I and IV also was deferred to that date.

d. RAC's participation in project CONAF is continuing; the CEM is being improved; and additional Army-prepared force structures will be analyzed.